United States
Department of
Agriculture

Research and
Education Committee

February 1992

1990 Annual Report on the Food and Agricultural Sciences

From the Secretary of Agriculture to the President and the Congress of the United States

PREFACE

This report was prepared as requested by Congress in the National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1410, as amended (7 U.S.C. 3125). Overall responsibility for development of the report was assigned to the Agricultural Research Service by the Assistant Secretary of Agriculture for Science and Education.

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CONTENTS

FEDERAL, STATE, AND PRIVATE INDUSTRY SUPPORT FOR THE FOOD AND AGRICULTURAL SCIENCES

DEPARTMENT OF AGRICULTURE

The U.S. Department of Agriculture's (USDA's) research and education (R&E) agencies supported food and agriculture research, extension, and teaching programs funded at approximately $1,544 million in fiscal year (FY) 1990, up 4.9 percent from FY 1989. These programs were centered in the Agricultural Research Service, Cooperative State Research Service, Extension Service, National Agricultural Library, Forest Service, and Economic Research Service. Other agencies having R&E activities include the Agricultural Cooperative Service, Animal and Plant Health Inspection Service, Agricultural Marketing Service, Human Nutrition Information Service, Office of International Cooperation and Development, Office of Transportation, National Agricultural Statistics Service, and Federal Grain Inspection Service. USDA R&E program funding for FY 1991 is estimated to be approximately $1,687.3 million (table 1).

The research and education programs of the Department are complementary and mutually supportive in providing new knowledge, technology, and information on food, agriculture, and forestry issues vital to producers, marketing firms, consumers, and action agencies. The results of these efforts affect the total economy of the United States and hundreds of millions of consumers here and abroad. Including input supply, production, processing, and marketing, the agriculture and forestry sectors accounted for approximately 15.4 percent of the gross national product and 16.6 percent of the civilian employment in the United States in 1990. These sectors also provided $17.7 billion in export trade surpluses in 1990. This helped to offset the U.S. trade deficit in other categories. At home, the cost of food to consumers as a share of disposable income continues to decline on a long-term basis.

In 1990, food required only about 11.8 percent of U.S. consumers' disposable income, down from 13.8 percent in 1980. At the farm level, food costs for U.S. consumers in 1990, as a percentage of disposable income, were only about 2.7 percent because overall, 76 percent of the cost of food is due to food marketing costs. For food eaten away from home, food marketing costs accounted for 84 percent of the bill. Thus, only 16 percent (or about as much as the usual server's tip) went back to the farmers who raised the food. In 1990, food marketing cost was $338 billion, up 5.5 percent from 1989. Labor costs alone for marketing, in 1990, were $154 billion compared with $106 billion for food at the U.S. farm level.

USDA R&E programs address national issues in production efficiency, export markets, marketing efficiency, biotechnology, natural resources management and conservation, environmental quality, human and community development, and human nutrition. R&E programs financed by the Department, encompassing this complex array of issues, are approximately 2.5 percent of the $67.2 billion obligated for all Federal research and development in FY 1991.

Funding for USDA R&E programs has increased in current dollars from $1,197.2 million in FY 1983 to $1,687.3 million for FY 1991 (table 1 and fig. 1).

However, the gain in current dollars for R&E was offset by inflation over the period. In constant 1983 dollars, funding was 4.8 percent more in FY 1991 than in FY 1983 (table 3 and fig. 2).

The overall R&E funding, year to year, in constant dollars over the FY 1983-91 period has tended to vary only modestly. USDA funding for research in constant dollars was highest in FY 1991 and next highest in FY 1985. Funding for education in constant dollars declined in seven of nine years during the FY 1983-91 period (table 2 and fig. 2).

Differences in funding were apparent among the R&E agencies. Six agencies operating R&E programs over the FY 1983-91 period had funding increases more than sufficient to cover inflation, and five did not receive increases large enough to cover inflation (table 3).

Table 1.

U.S. Department of Agriculture: Appropriations for research and education, FY 1983-91

Item	1983	1984	1985	1986[1/]	1987	1988	1989	1990[1/]	1991
	Million Dollars								
RESEARCH									
Agricultural Research Service[2/]	451.9	471.1	491.4	483.2	511.4	544.2	569.4	593.3	631.6
Cooperative State Research Service									
Hatch Act Formula	147.2	152.3	155.4	148.8	148.8	155.5	155.5	155.1	162.3
Cooperative Forestry	12.4	12.7	13.1	12.4	12.4	17.5	17.5	17.3	17.8
1890 Colleges and Tuskegee	21.8	22.8	22.8	22.3	22.3	23.3	24.3	25.0	26.3
Special Research Grants	27.8	26.5	32.0	30.2	55.1	51.8	61.7	73.1	78.5
Competitive Research Grants	17.0	17.0	46.0	42.3	40.7	42.4	39.7	38.6	73.0
Animal Health and Disease	5.8	5.8	5.8	5.5	5.5	5.5	5.5	5.4	5.6
Direct Federal Administration	0.3	0.6	1.5	1.6	2.9	4.1	6.4	8.2	9.6
Forestry Competitive Grants	0.0	0.0	7.8	6.5	6.0	3.0	0.0	3.9	0.0
Total, CSRS[3/]	232.3	237.7	284.4	269.6	293.7	303.1	310.6	326.6	373.1
National Ag. Statistics Service	7.6	8.2	8.4	8.0	3.4	3.6	2.9	2.8	2.9
Economic Research Service	38.9	44.3	46.6	44.1	44.9	48.3	49.6	51.0	54.8
Human Nutrition Info. Service	7.7	6.1	7.5	12.9	7.0	8.6	8.8	9.0	9.9
Animal & Plant Health Insp. Svc.	0.0	0.0	0.0	4.4	4.9	6.6	11.3	13.0	13.8
Agricultural Coop. Service	2.2	2.2	2.9	2.7	2.7	2.7	2.7	3.4	3.4
Agricultural Marketing Service	1.5	1.6	1.6	1.5	1.5	1.6	1.6	1.7	3.0
Office of Transportation	0.8	0.8	1.3	1.1	1.0	1.0	1.0	1.0	0.0
Office of Int. Coop. & Dev.	5.5	5.3	5.4	3.1	4.2	1.5	1.3	2.3	2.6
Forest Service	107.7	109.4	113.8	113.6	126.7	132.5	138.3	150.9	167.6
Federal Grain Inspection Service	0.6	0.7	1.1	0.9	0.8	1.0	0.4	0.3	0.7
Total, Research[4/]	856.7	887.4	964.4	945.1	1002.2	1054.7	1097.9	1155.3	1263.4
EDUCATION									
Extension Service									
Smith-Lever 3(b&c) Formula	230.4	235.0	241.5	229.7	235.9	241.6	241.6	242.3	252.6
Other Extension Programs[4/]	92.8	93.8	93.9	93.1	96.8	99.5	101.2	108.9	127.2
Direct Federal Administration	5.4	5.5	5.9	5.2	6.3	7.4	9.1	8.7	9.2
Total, Extension Service	328.6	334.3	341.3	328.0	339.0	348.5	351.9	359.9	389.0
Cooperative State Research Service									
Morrill-Nelson	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Competitive Fellowship Grants	0.0	5.0	5.0	2.9	2.9	2.9	2.9	2.8	3.5
1890 Colleges Grants	0.0	0.0	2.0	1.9	1.9	1.9	1.9	1.9	2.0
Competitive Challenge Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.5
1890 Capacity Building Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4	8.3
Total, CSRS	2.8	7.8	9.8	7.6	7.6	7.6	7.6	13.9	18.1
National Agricultural Library	9.1	10.4	11.5	10.8	11.1	12.2	14.3	14.7	16.8
Total, Education	340.5	352.5	362.6	346.4	357.7	368.3	373.8	388.5	423.9
TOTAL, Research & Education	1197.2	1239.9	1327.0	1291.5	1359.9	1423.0	1471.7	1543.8	1687.3

1/ Reflects reduction under P.L. 99-177, the Balanced Budget and Emergency Deficit Control Act of 1985.

2/ Excludes funds appropriated to ARS for construction, which have been (in millions of dollars): $4.9 ('83), $77.9 ('84), $22.4 ('85), $6.0 ('86), $1.0 ('87), $15.3 ('88), $17.0 ('89), $12.7 ('90), and $41.0 ('91).

3/ Excludes 1890 Colleges and Tuskegee Research Facilities funding, which has been $10.0 million annually from FY '83 through FY '85 and $9.5 million each in FY '86 and FY '87; and facility funding (in millions of dollars): $66.6 ('87), $42.5 ('88), $23 ('89), $45.1 ('90), and $62.9 ('91).

4/ Excludes 1890 Colleges and Tuskegee Extension Facilities funding of $9.5 million annually in FY '88 and FY '89, $9.4 million in '90, and $9.5 million in '91.

Source: Office of Budget and Program Analysis (OBPA), USDA.

Funding for research and education programs increased in current dollars between FY 1983 and FY 1991; however,...

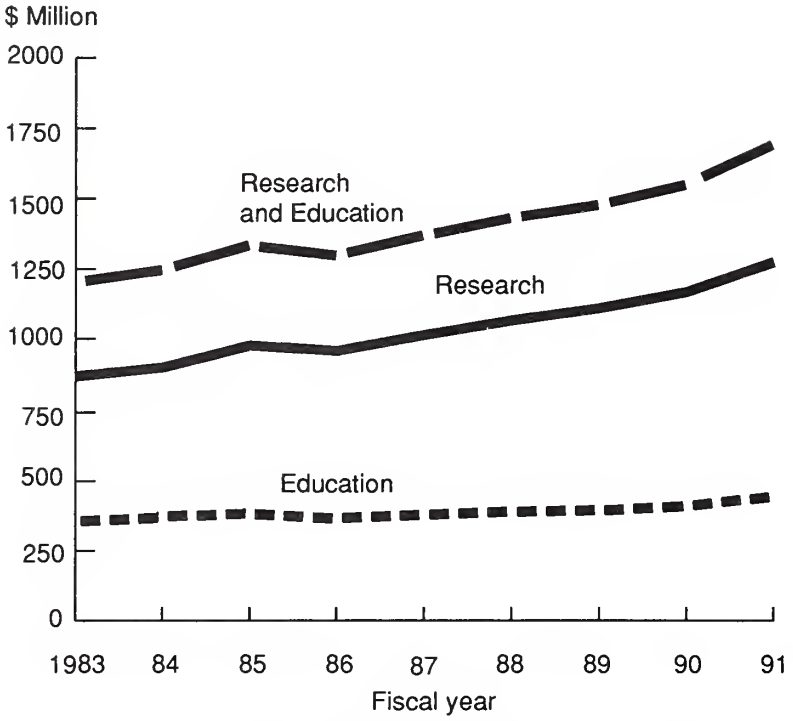

Figure 1. USDA appropriations for R&D (current dollars)
(Source: OBPA, USDA)

...that gain was largely offset by inflation over the same period.

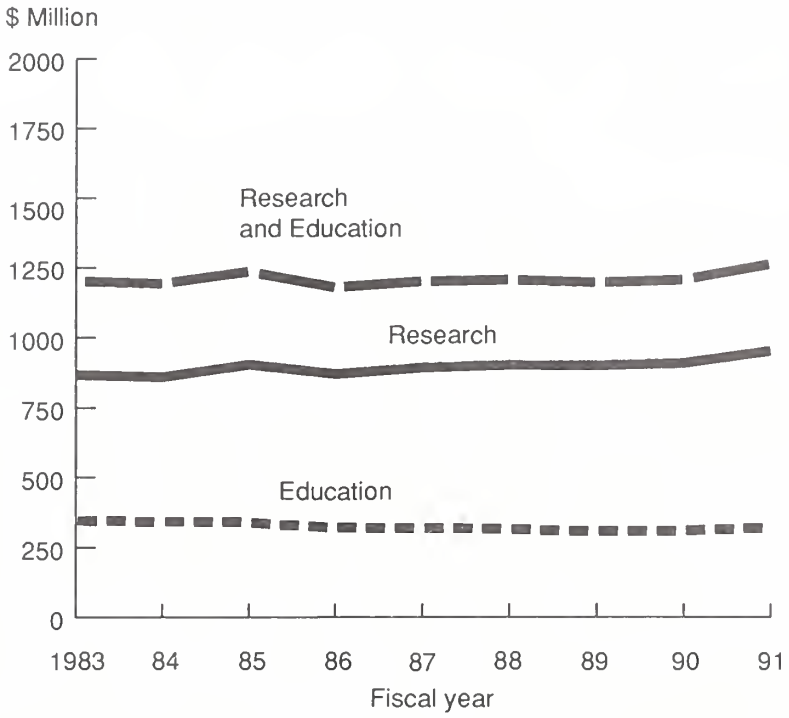

Figure 2. USDA appropriations for R&D (constant dollars) (Source: OBPA, USDA)

Table 2.

U.S. Department of Agriculture: Appropriations for research and education in constant 1983 dollars, FY 1983-91

Item	1983	1984	1985	1986	1987	1988	1989	1990	1991
Inflation rate	4.0%	4.4%	3.4%	2.0%	3.5%	4.1%	4.3%	4.0%	4.4%
GNP Deflator for Gov't. Purchases Index: (1982=100)	104.0	108.6	112.3	114.5	118.5	123.4	128.7	133.9	139.8
	----------Million Dollars----------								
RESEARCH									
Agricultural Research Service	451.9	451.1	455.1	438.9	448.8	458.6	460.1	460.8	469.9
Cooperative State Research Service									
Hatch Act Formula	147.2	145.8	143.9	135.2	130.6	131.1	125.7	120.5	120.7
Cooperative Forestry	12.4	12.2	12.1	11.3	10.9	14.7	14.1	13.4	13.2
1890 Colleges and Tuskegee	21.8	21.8	21.1	20.3	19.6	19.6	19.6	19.4	19.6
Special Research Grants	27.8	25.4	29.6	27.4	48.4	43.7	49.9	56.8	58.4
Competitive Research Grants	17.0	16.3	42.6	38.4	35.7	35.7	32.1	30.0	54.3
Animal Health and Disease	5.8	5.6	5.4	5.0	4.8	4.6	4.4	4.2	4.2
Direct Federal Administration	0.3	0.6	1.4	1.5	2.5	3.5	5.2	6.4	7.1
Forestry Competitive Grants	0.0	0.0	7.2	5.9	5.3	2.5	0.0	3.0	0.0
Total, CSRS	232.3	227.6	263.4	244.9	257.8	255.4	251.0	253.7	277.6
National Ag. Statistics Service	7.6	7.9	7.8	7.3	3.0	3.0	2.3	2.2	2.2
Economic Research Service	38.9	42.4	43.2	40.1	39.4	40.7	40.1	39.6	40.8
Human Nutrition Info. Service	7.7	5.8	6.9	11.7	6.1	7.2	7.1	7.0	7.4
Animal & Plant Health Insp. Svc.	0.0	0.0	0.0	4.0	4.3	5.6	9.1	10.1	10.3
Agricultural Coop. Service	2.2	2.1	2.7	2.5	2.4	2.3	2.2	2.6	2.5
Agricultural Marketing Service	1.5	1.5	1.5	1.4	1.3	1.3	1.3	1.3	2.2
Office of Transportation	0.8	0.8	1.2	1.0	0.9	0.8	0.8	0.8	0.0
Office of Int. Coop. and Dev.	5.5	5.1	5.0	2.8	3.7	1.3	1.1	1.8	1.9
Forest Service	107.7	104.8	105.4	103.2	111.2	111.7	111.8	117.2	124.7
Federal Grain Inspection Service	0.6	0.7	1.0	0.8	0.7	0.8	0.3	0.2	0.5
Total, Research	856.7	849.8	893.1	858.4	879.6	888.9	887.2	897.3	939.9
EDUCATION									
Extension Service									
Smith-Lever 3(b&c) Formula	230.4	225.0	223.7	208.6	207.0	203.6	195.2	188.2	187.9
Other Extension Programs	92.8	89.8	87.0	84.6	85.0	83.9	81.8	84.6	94.6
Direct Federal Admin.	5.4	5.3	5.5	4.7	5.5	6.2	7.4	6.8	6.8
Total, Extension Service	328.6	320.1	316.1	297.9	297.5	293.7	284.4	279.5	289.4
Cooperative State Research Service									
Morrill-Nelson	2.8	2.7	2.6	2.5	2.5	2.4	2.3	2.2	2.1
Competitive Fellowship Grants	0.0	4.8	4.6	2.6	2.5	2.4	2.3	2.2	2.6
1890 Colleges Grants	0.0	0.0	1.9	1.7	1.7	1.6	1.5	1.5	1.5
Competitive Challenge Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.1
1890 Capacity Building Grants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	6.2
Total, CSRS	2.8	7.5	9.1	6.9	6.7	6.4	6.1	10.8	13.5
National Agricultural Library	9.1	10.0	10.7	9.8	9.7	10.3	11.6	11.4	12.5
Total, Education	340.5	337.6	335.8	314.6	313.9	310.4	302.1	301.7	315.3
TOTAL, Research and Education	1197.2	1187.4	1228.9	1173.1	1193.5	1199.3	1189.3	1199.1	1255.2

Source: OBPA, USDA.

Table 3.

U.S. Department of Agriculture: Percent changes in appropriations for research and education programs, by Agency, from FY 1983 to 1991 in constant 1983 and current dollars.

Agency	Constant 1983 dollars	Current dollars
Research	Percent	Percent
Agricultural Research Service	+4.0	+39.8
Cooperative State Research Service	+19.5	+60.6
National Agricultural Statistics Service	-71.0	-61.8
Economic Research Service	+4.9	+40.9
Human Nutrition Information Service	-3.9	+28.6
Animal and Plant Health Inspection Service[1/]	--	--
Agricultural Cooperative Service	+13.6	+54.5
Agricultural Marketing Service[2/]	+46.7	+100.0
Office of International Cooperation and Devel.	-65.5	-52.7
Forest Service	+15.8	+55.6
Federal Grain Inspection Service	-16.7	+16.6
Total, research	+9.7	+47.5
Education		
Extension Service	-11.9	+18.4
Cooperative State Research Service	+382.1	+546.4
National Agricultural Library	+37.4	+84.6
Total, education	-7.4	+24.5
Total, research and education	+4.8	+41.0

1/ Appropriations were zero in 1983 and increased to $13.8 million by FY '91 in current dollars.

2/ The Office of Transportation will be merged into the Agricultural Marketing Service in FY '91.

STATE AND COUNTY SUPPORT

State and county support for research and education for the food, fiber, and forestry system at about $1.9 billion in 1990 was 19 percent greater than the Federal contribution of about $1.6 billion. Combined Federal, State, and county funds support approximately 11,000 scientists and 15,000 extension personnel, who are the formulators and extenders of knowledge needed by the Nation's largest industry. Public investment in food and agriculture research and education has consistently provided annual returns of 30 percent or more.

State support for the food and agricultural sciences is provided primarily through the land-grant institutions (1862, 1890, forestry schools, and Tuskegee University) and includes funds for research, extension, and higher education. However, an estimated 50 State-supported, non-land-grant institutions also have agricultural programs. These programs are primarily devoted to higher education.

PRIVATE INDUSTRY RESEARCH AND DEVELOPMENT

The report "A Survey of U.S. Agricultural Research by Private Industry III," published in July 1985 by the Agricultural Research Institute (ARI) of Bethesda, MD, stated that "the best estimate of private industry annual expenditures in agricultural research (is) approximately 2.1 billion dollars." Adjusted for inflation, this estimate would have increased to about $2.6 billion in 1990.

Industry also provided funds to public research organizations to conduct research projects. In 1990 this totaled slightly more than $0.1 billion. Thus total industry support for agricultural research and development in 1990 approximated $2.7 billion.

Based on ARI data, industry overall is apparently devoting approximately 15 percent of its research and development expenditures to basic research, 43.5 percent to applied research, and 41.5 percent to developmental research. However, 62 percent of the companies responding to an ARI survey reported doing no basic research and 36.5 percent reported doing no research of any kind.

Major areas of research conducted by industry, as reported by ARI, are in pesticides, plant breeding, and human food. These three areas accounted for nearly two-thirds of the agricultural research carried out by industry.

FUTURE PRIORITIES FOR THE FOOD AND AGRICULTURAL SCIENCES

JOINT COUNCIL

Each year the Joint Council on Food and Agricultural Sciences prepares a report to the Secretary of Agriculture on future priorities for the food and agricultural sciences. This report precedes the submission to Congress of the Department's budget for the fiscal year 2 years in the future. In June 1990, the Joint Council published a report entitled "Fiscal Year 1992 Priorities for Research, Extension, and Higher Education,"[1] which indicated that the Joint Council's priorities for FY 1992 were as follows:

- Compatibility and Sustainability of Agriculture and the Environment
- Global Competitiveness and Expansion of Agricultural Markets
- Abundant, Affordable, Safe, and Nutritious Food for Optimal Health
- Scientific and Professional Expertise in the Food and Agricultural Sciences
- Social Stability and Changing Values in America

USER'S ADVISORY BOARD

In its 1990 Report to the President and Congress,[2] the User's Advisory Board focused on five critical issues. These were

- Global Competition
- Biotechnology
- Declining Science Education
- Quality and Confidence
- Rural Development

These priorities and issues, along with input from internal plans and reports from scientific organizations, other advisory committees, commodity organizations, and others, form the basis for research and extension planning within the Department. Recent budgets have included increases for water quality, global change, food safety, biotechnology, and other programs in coordination with other USDA and Federal and State agencies. Plans for those programs indicate a continuing commitment for support to solve critical issues facing agricultural producers, processors, and consumers.

[1] Copies of this report can be obtained from Joint Council Secretariat, Aerospace Building, Suite 302, U.S. Department of Agriculture, Washington, DC 20250-2200, telephone (202) 401-4662.

[2] Copies of this report are available from User's Advisory Board Secretariat, Room 432A, Administration Building, U.S. Department of Agriculture, Washington, DC 20250-2200, telephone (202) 720-3684.

AGRICULTURAL RESEARCH SERVICE

The Agricultural Research Service (ARS) conducts mission-oriented research to ensure a continuing abundance of high-quality, nutritious, reasonably priced food and other agricultural products to meet domestic and world needs while maintaining environmental quality. ARS uses coordinated, interdisciplinary approaches to conduct basic and applied research pertaining to soil and water conservation, plant sciences, animal sciences, commodity conversion and delivery, human nutrition, and integration of agricultural systems.

Research is conducted at numerous locations in the United States, including Puerto Rico and the Virgin Islands, and in several foreign countries. When appropriate, research is conducted in cooperation with the State agricultural experiment stations, other State and Federal agencies, and private institutions.

Patent Licenses Awarded Increase to 31

Thirty-one licenses were awarded on ARS patents and patents pending in FY 1990, an increase of 41 percent over those in FY 1989. Of the 31 licenses, 22 were exclusive and 9 nonexclusive. Total income from these and previous patent licenses exceeded $550,000 in FY 1990, compared to $85,000 in 1987, $97,000 in FY 1988, and $418,000 in FY 1989.

Technology-Transfer Achievements Honored

Ten ARS scientists were honored for their roles in the successful transfer of technology that they had developed. Individual cash awards of $500 to $2,500 were provided from patent-license revenues. Transferred technologies include techniques for metering waterflow in irrigation canals, newsprint made from kenaf, computer models to improve food-processing efficiency, fabrics that modulate temperature, improved control of avian coccidiosis, a leather-curing process using radiation, and a trap for Africanized honeybees.

Soil Losses Reduced by 50 Percent

In the northern Great Plains, conventional tillage combined with monoculture (wheat-fallow rotation) is causing excessive soil erosion by wind. The use of minimum-till and no-till practices and modern water-conservation technology makes continuous cropping economically feasible for diverse crop rotations. The inclusion of an oilseed crop in place of a wheat-fallow rotation helps to break the cycles of weeds, insects, and diseases and thereby reduces the use of herbicide. A conservation-tillage farming system has been developed for sunflower in a rotation with cereal grains, which provides a residue cover of 40-60 percent to protect the soil resources. Adoption of these research findings should reduce soil losses to wind and water erosion by more than 50 percent.

Lower Nitrates in Groundwater and Higher Profits Possible With Computer Model

Several State and Environmental Protection Agency surveys of water quality show that many rural and domestic water supplies in irrigated regions have elevated concentrations of nitrate and pesticides. Cooperative research with the University of Nebraska at Lincoln has resulted in the development of a computer model for estimating requirements of fertilizer nitrogen and irrigation water. On the average, nitrogen applications can be reduced by

about 50 pounds per acre without reducing yields, thereby increasing the farmer's net profit and reducing the amount of nitrate entering groundwater.

A new site for research and evaluation is being established to demonstrate the benefits of new practices of nitrogen and water management and to promote, in cooperation with the Cooperative Extension System, their use in irrigated agriculture.

Higher Levels of Carbon Dioxide To Benefit Crops

The annual average concentration of carbon dioxide in the atmosphere has risen 30 percent during the last century and is expected to double from present levels during the next century. Research conducted in controlled growth chambers, greenhouses, and open-top field chambers and in a free-air carbon-dioxide enrichment experiment has shown that an increase in carbon dioxide (1) enhances the yield of all crops tested (some yields double with a doubling in concentration), (2) coupled with a temperature increase gives many nongrass plant species a competitive advantage, (3) enhances root growth as much as or more than top growth, and (4) reduces water use per unit of leaf area.

Hessian Fly Foiled by New Wheat Genes

ARS and Moroccan scientists have discovered a north African durum-wheat germplasm that provides new genes resistant to Hessian fly in the United States. The germplasm is expected to provide farmers a source of protection against the insect well into the next century. In turn, several resistance genes in U.S. wheats were found to be highly effective against Hessian fly in Morocco. This has resulted in the release of a resistant spring wheat to Morocco. The wheat was developed by ARS and South Dakota State University.

Use of Pesticide on Cotton Can Be Reduced by Bait Stick

The boll weevil is a major pest of cotton in the United States. Without adequate measures of chemical control, this pest would reduce cotton production in the United States by 30-35 percent. In addition, the application of pesticides made for this pest hinders attempts to use biological control agents against other cotton pests. So ARS scientists have combined an attractant, a feeding stimulant, and a small amount of insecticide in a formulation that can be applied to sticks placed in cotton fields. Boll weevils are attracted to this device, feed on it, and are rapidly killed. The inexpensive devices are effective for 6 weeks and can be removed and destroyed after use. This attracticide system is specific for the boll weevil and avoids the destruction of beneficial insects. Initial test results indicate up to 80 percent suppression of boll weevils with the use of one device per acre.

High-Yield, High-Protein Soybean

Domestic and foreign processors need soybeans with higher levels of protein for producing soybean meal used in poultry and livestock feeds worldwide. Previously, soybeans that had high levels of protein were also lower in yield, and farmers could not afford to grow them. ARS scientists have used a new breeding method that has made it possible to increase seed protein by 4 percent without sacrificing yield. This breakthrough will enable U.S. growers to produce higher protein soybeans, which will be more competitive in global markets.

Apple Bruising Reduced 50 Percent

Bruise damage is the primary cause of loss of quality and grade in fresh-market apples. A 50-percent decrease in bruising of apples was accomplished by ARS scientists. Researchers modified a commercial grading and packing line with shag carpeting to soften the blow of falling apples. The scientists further reduced bruising by covering metal surfaces of equipment with a vinyl material. A spherical sensor (developed earlier by ARS) that simulated an apple was used to identify potential points of damage in the grading/packing lines. The changes were made permanent at the commercial packing lines where the study was conducted. The modifications resulted in a 35-percent increase in the U.S. Department of Agriculture (USDA) grade of apples.

Coccidiosis Vaccine Nearly 100 Percent Effective

Avian coccidiosis, an intestinal disease of chickens, costs U.S. poultry farmers $300 million annually for medication and because of lower weight gain in chickens. ARS scientists have developed an experimental vaccine that is made by exposing the infective stage of the coccidial parasite to X rays. The vaccine has been nearly 100 percent effective in protecting young birds from the disease. Lengthy testing must still be done before this vaccine can be released for commercial use.

New Genetic Engineering Technique Used by 100 Labs

Through genetic engineering, new methods of pest management may be devised to enhance the productivity of livestock and agricultural crops. Genetic engineering may be one step closer because of a new technique, developed by ARS, for injecting deoxyribonucleic acid (DNA). Using extremely fine silicone-carbide needles to puncture cell nuclei, scientists can now more effectively insert desirable DNA into the genetic makeup of plants and animals. The new gene-insertion method is patented by USDA and is being used by more than 100 laboratories worldwide.

Tissue Culture Developed for Animal Embryos

Sheep embryos can be kept alive and developing outside the mother using tissue culture cells as "wet nurses." The technique, called coculture of embryos, was developed by ARS scientists in Beltsville, MD. New embryos are placed in cultures of cells from a sheep's oviduct--the tube through which the developing egg moves on its way to the uterus. Scientists speculate that certain nutrients from the cultured cells keep the embryos alive and developing. So far, the scientists have had a 30-percent success rate in implanting embryos, cultured for 3 days, in surrogate ewes. The technique could eventually lead to stocks of culture cells in which the nuclei contain genes with desired traits. These would be the source of new genes to be transferred to developing embryos. Tests of coculturing cattle embryos are under way.

Beef Twinning May Reduce Costs by 25-30 Percent

More than 50 percent of the feed units used by the Nation's beef herd is needed to meet maintenance requirements of the reproducing females. Small differences in the reproduction rates of beef cattle can have a major effect on the costs of production. Scientists at Clay Center, NE, have developed selection criteria and procedures for increasing the twinning rate in cattle. Based on 700 calvings, the researchers observed a high genetic correlation between the ovulation rate in pubertal heifers and their twinning

rate as cows. Using cows that had produced twins and some sires whose daughters produced twins at a frequency of about 10 percent, scientists after one generation of intrapopulation selection are now achieving a twinning rate of about 20 percent in the experimental population. The average twinning rate in most beef populations is less than 2 percent. For highly intensive management systems, a twinning technology has the potential of reducing costs per unit of beef output by 25-30 percent for the proportion of the herd producing twins, compared to that producing singles.

Diseases Diagnosed by Gene Probes

Swine dysentery, Johne's disease, and leptospirosis are major causes of economic loss and animal suffering. Leptospirosis can also be transmitted from animals to humans. All three diseases establish a carrier state in which apparently healthy animals perpetuate the disease by excreting the causative bacteria. The detection of carriers is essential for control, but conventional methods of diagnosis are inadequate because the bacteria are particularly difficult to isolate and differentiate from nonpathogenic organisms. ARS investigators at the National Animal Disease Center in Ames, IA, along with collaborators at the University of Wisconsin-Madison and the IDEXX Corporation, developed diagnostic gene probes for these three diseases. The probes enable workers to detect nucleic-acid sequences that are unique to these bacterial pathogens in urine or feces and that provide an unprecedented degree of specificity in diagnosing these diseases. In addition, compared with conventional culture techniques, these probes reduce the time required for diagnosis from months (in the case of Johne's disease and leptospirosis) to hours.

Cause of Reproductive Failure in Swine Identified

Reproductive failure is a major economic problem for the swine industry. In many instances, rational control programs cannot be developed or applied because the cause of the reproductive failure cannot be diagnosed. This problem has recently been of particular concern to the industry in the form of the "mystery disease syndrome" of pigs. ARS research has demonstrated that leptospirosis of the bratislava type is a significant and previously unrecognized cause of reproductive failure in U.S. swine. Knowledge of this agent as a potential cause of reproductive failure may now permit a definitive diagnosis to be made in many cases.

Meat Safety Assured

Bacterial contamination of beef during slaughter adversely affects its safety and quality. ARS scientists have developed a three-pronged approach to combat this contamination. These are (1) washing of the carcass before evisceration, (2) modified spray chilling of the eviscerated carcass with acetic acid, and (3) spraying the carcass with salt solutions or physical dehydration to enhance the effectiveness of organic acids in sanitizing beef carcasses. The use of these three processes can potentially reduce Salmonella and other hazardous bacteria by 99.9 percent, which is a goal of USDA's Food Safety and Inspection Service.

Starch May Improve Water Quality

A cost-effective pesticide-starch encapsulation holds promise for improved water quality. ARS scientists devised a rapid, continuous, highly efficient, and relatively inexpensive process for encapsulating a broad range of

chemical pesticides in a starch matrix. This process, based on twin-screw extrusion, has been scaled up at a commercial facility. Thousand-pound quantities of three starch-encapsulated herbicides have been prepared and supplied to weed scientists. In a multistate study, they will attempt to determine the efficiency for weed control and the potential for reducing groundwater contamination by herbicides. Three companies are exploring a license to the technology.

Shelf Life of Fruits and Vegetables Improved by Edible Film

To prevent spoilage and retain the freshly picked appearance that consumers demand, most fruits and some vegetables are coated and then shipped and stored at lower temperatures. Energy costs, the limited acceptability of certain coatings, and the poor performance of some coatings are major problems with the present system. ARS scientists developed an inexpensive edible coating composed of oils, cellulose, and an emulsifier that provides the desired gloss and extended shelf life at temperatures well above normal refrigeration. The coating forms a barrier to moisture loss and to air or oxygen exchange. In essence, a microcontrolled atmosphere is created that prevents spoilage and provides uniform delay of ripening at room temperature. In citrus, the coating also improves the retention of fruity volatiles that are so important to flavor. Appropriate extension of this technology to exports should increase the U.S. ability to deliver quality at reduced energy cost.

Biocontrol Alternatives to Fumigation

Domestic and foreign consumers are concerned with pesticide residues and demand alternative measures for the control of pests, particularly quarantined pests. Scientists at the ARS facility in Fresno, CA, evaluated the use of a synthetic pheromone to disrupt mating of the codling moth in inshell walnuts destined for export to Japan, a $9 million market. Complete control of such mating can be obtained with this procedure and may thus be an acceptable alternative to the fumigants presently used.

Caloric Needs of Nursing Mothers Measured

Precisely how many calories a mother requires to maintain adequate milk production for her infant and to safeguard her own health is not known. Hence, the energy expenditures of lactating, nonlactating post-partum, and nulliparous women all consuming usual diets were measured by indirect calorimetry in Houston, TX. It was found that the metabolic rate after each meal increased in lactating women compared to that in nonlactating women, whereas basal metabolic rates were not affected. Lactating women do require more energy than women who are not breast-feeding because of the production of milk itself and because of the elevated metabolic rates during the digestion of a meal. This information will be useful in determining the actual energy requirements of nursing mothers.

Brain Function Affected by Boron

The role of boron (a trace element found in fruits, vegetables, and legumes) in the mental function of adults is not clear. In a previous study, changes in the electrical activity of the brain were observed in women with different boron intakes. The lower boron levels resulted in patterns of activity typically associated with reduced arousal and decreased mental alertness. However, no controls were included for possible seasonal effects. A recent

study examined the effect of boron intake on electrical activity of the brain in rats, controlled for time effects. The rats fed low-boron diets showed decreased electrical activity on both the right and left sides of the brain and a shift in the pattern of activity consistent with that observed in the human study. These observations confirm the earlier findings with women and suggest that boron may play an important role in maintaining normal brain function.

Health Impaired by Lack of Magnesium

Magnesium is involved in numerous life processes, and it has been suggested that low intakes of this element contribute to the cause of several human disorders, including osteoporosis and ischemic heart disease. Efforts to produce magnesium deficiency in adult humans have generally been unsuccessful. Studies at Grand Forks, ND, were conducted in healthy, postmenopausal women consuming low-magnesium diets. It was necessary to place some of the subjects on magnesium-adequate diets before the end of the study because they showed heart-rhythm abnormalities suspected to have been caused by low-magnesium intakes. Low-magnesium intakes depressed total and low-density lipoprotein (LDL) plasma cholesterol and also significantly elevated mean red-cell volume and hemoglobin concentration. These findings indicate that significant effects can be induced by inadequate intakes of magnesium in healthy adults. The results also help to define the importance of magnesium in the prevention of some human disorders.

Bacterial Levels in Food Monitored Via Computer

Food processors can use a new computer program to drastically cut the number of laboratory tests required to monitor the bacterial levels in foods. Although not 100 percent accurate, the computer program can reduce by 75 percent the number of tests needed to track the growth of Salmonella and Listeria, two food-poisoning bacteria found in meat and dairy products. The model, developed by ARS researchers in Philadelphia, PA, predicts how factors such as acidity and salt influence bacterial growth. The program is being refined so that it can also track the bacteria Shigella, Aeromonas, and Staphylococcus. About 300 companies are interested in using this program.

Gauging Effects of Global Warming on Water Supplies

Climate changes could result in higher-than-normal streamflow in early spring but a greater-than-normal decrease in flow in June and July. This could mean bad news for farmers in the Western United States. The need for irrigation water there is heaviest during these two months. For example, computer simulation of the Rio Grande Basin in Colorado showed that an increase of $3^{o}C$ and a 25-percent loss in winter-snow accumulation due to a warmer climate can result in a 30-percent decrease in total seasonal runoff. If such a decrease were to occur in many western basins, it could seriously aggravate the already existing problem of too little water. ARS hydrologists in Beltsville, MD, in cooperation with University of Maryland researchers, are using the computer modeling to help develop ways to combat these losses in streamflow.

COOPERATIVE STATE RESEARCH SERVICE

The mission of the Cooperative State Research Service (CSRS) is to advance science and technology in support of agriculture, forestry, people, and communities, in partnership with the State Agricultural Experiment Station System, colleges, universities, and other research organizations, and in consonance with the Secretary of Agriculture and the intent of Congress. CSRS scientists work with regional and national groups to assure the quality of science and to set research priorities. The agency administers U.S. Department of Agriculture (USDA) research funds appropriated by Congress for the States, gives focus to the broad programs of agricultural research and education in the States, and participates in a nationwide system of research planning and coordination. It also supports and encourages efforts aimed at providing the food and agricultural expertise required by the Nation's modern, high-technology, knowledge-based system.

State Cooperators

The programs of CSRS are carried out cooperatively with the following:

- 59 State and Territorial agricultural experiment stations;
- 17 of the 1890 colleges, including Tuskegee University;
- 28 schools of forestry; and
- 28 colleges of veterinary medicine.

Most of these institutions are associated with the land-grant universities. When all publicly supported agricultural research is taken into account, including all research agencies within USDA, two-thirds of the full-time equivalent scientist-years are found in the State Agricultural Experiment Station System. Because of shared responsibilities between research and teaching in the universities, the actual number of scientists is far larger. This provides a wide range of talent capable of addressing most kinds of problems faced by agriculture.

Water Quality and Agricultural Practices Studied

Research is being conducted under a special Presidential Initiative to improve and expand knowledge of the relationships between agricultural practices and water quality. This research is being conducted under two major CSRS water-quality research programs: a National Components Research Program, in which recipients of special research awards are competitively selected; and the Midwest Initiative on Water Quality, a long-term, multiagency, State-Federal program to evaluate agricultural production management systems that are both economically and environmentally beneficial.

Projects Funded in National Components Research Program

One hundred thirteen water-quality research projects were funded under the National Components Research Program in five major areas. The areas are sources, assessment, and prevention of water pollution; movement, persistence, and degradation of pesticides and other chemicals in soil and water; remediation of contaminated soil and water; economic and sociological

impacts of water pollution and its control; and agricultural management practices and systems for water-quality protection.

Midwest Initiative on Water Quality

The Midwest Initiative on Water Quality is being jointly conducted by CSRS and the State agricultural experiment stations in cooperation with the Agricultural Research Service, Environmental Protection Agency, U.S. Geological Survey, Extension Service, and numerous other State and Federal agencies. Five areas of management-system evaluation have been selected at major sites in Iowa, Minnesota, Missouri, Nebraska, and Ohio, with supporting research in five other Midwestern States. Research at these locations focuses on the evaluation of agricultural management systems in intensively cropped areas for their economic profitability and environmental benefits.

Inhibitors of Plant Hormones Studied

Ethylene is one of the five major plant hormones that affect the growth, development, and aging of plants. Researchers at the University of California, Davis, have determined the biosynthetic pathway of ethylene. Their discovery of key enzymes that regulate ethylene biosynthesis has contributed significantly to the understanding of ethylene as a plant hormone and has allowed the further discovery of inhibitors to these enzymes. Such inhibitors have been shown to effectively suppress the production of ethylene. The use of these inhibitors has resulted in a prolonged shelf life of cut flowers and harvested fruit.

Pathogenesis of Plant Virus Studied

The process by which plant viruses cause disease in their host is controlled by the virus via its genetic alterations of the host's genetic structure. Researchers at the University of Nebraska at Lincoln have determined the sequence of the genome of the virus for turnip crinkle. Structural studies were undertaken in an effort to define the interaction of specific proteins with genetic material at the molecular level. With the genome organization now in hand, questions can be addressed to identify the major factors involved in the disease physiology. Although turnip crinkle does not cause serious disease in the turnip, it is an extremely serious disease in a wide variety of other vegetables, in fruit-tree crops, and in other horticultural crops. Indepth knowledge of the genome structure of this system should impact future control measures.

Technology Being Developed for Alcohol Fuels

University of Florida (Gainesville, FL) scientists introduced certain genes from one organism to another organism so that certain sugars present in whey and other waste sources could be efficiently converted to alcohol. As a result, a recombinant bacterium, Escherichia coli, was infected with these genes and is now capable of producing ethanol very rapidly from sugars that are components of the walls of plant cells and the storage tissue of plants. U.S. Patent No. 5,000,000 was granted to these scientists for their research effort. The scientists will extend this work to other bacteria so that technologies can be developed to degrade cellulose and other agricultural biomasses for the production of alcohol fuels.

Fall Armyworm Studied

Few details of the life history and basic biology of many agricultural pests are known. This is particularly true for highly migratory species that

reside primarily or solely in the Neotropics during temperate winters. The fall armyworm is one of these migrants, and scanty information exists about its basic biology in tropical and subtropical regions. Unfortunately, all studies are compromised by the existence of two strains of the fall armyworm. Nearly every characteristic studied on these strains differs, including seasonal presence and mating behavior. Researchers at Louisiana State University (Baton Rouge) are evaluating these differences across geography by contrasting tropical with temperate populations. In addition, these studies are critical for understanding the ecology and evolution of the fall-armyworm strains. Effective management practices for this important pest depend on acquiring information on its dispersal and reproductive behaviors.

Products High in Erucic Acid Studied

In cooperation with International Lubricants Inc. of Seattle, WA, CSRS tested an automatic transmission fluid (ATF) and an ATF supplement at an independent third-party laboratory. These lubricants contained high-erucic-acid derivatives from industrial rapeseed oil. The ATF supplement contained 51 percent rapeseed-oil derivatives. The supplement reduced wear by over 50 percent compared with a factory-fill ATF, and other properties of the supplement were at least as good as those of the factory-fill ATF. Other lubricants, paints, coatings, nylons, and plastics with excellent properties can be made from oils high in erucic acid. The program was successful in attracting National Sun Industries to contract with farmers to grow 2,200 acres of crambe in North Dakota in an experimental program. The company successfully crushed the seed and sold the oil and meal products. National Sun Industries would like to contract for 10,000 acres of crambe in 1991.

Technology Developed for Newsprint and Other Products From Kenaf

In a joint venture led by Kenaf International, plans were announced for a small mill to be built in southern Texas to make commercial newsprint from kenaf. This follows the successful demonstration of printing on kenaf newsprint and the development and successful demonstration of a kenaf harvester. The United States imports about 60 percent of its newsprint. Development continues for other kenaf-product applications such as packaging, lightweight coated sheeting, linerboard, poultry litter, and livestock feed.

Natural Rubber and Coproducts Made From Guayule

Under contract with USDA and in cooperation with the U.S. Department of Defense, Firestone Tire and Rubber Company has completed operations at an Arizona pilot facility to process natural rubber from guayule, a desert shrub native to the Southwest. Rubber has been delivered to Firestone and to Goodyear Tire and Rubber Company for manufacturing and testing tires on aircraft (Navy A4 and F18) and on Army light trucks. The United States imports 100 percent of its natural rubber.

Hydroxy Fatty Acids May Be Made From Castor and Lesquerella Oils

Derivatives of hydroxy fatty acids are critical and strategic materials because they are used in making greases and lubricants. Yet the United States imports 100 percent of the hydroxy fatty acids used in this country. Other uses include coatings (for example, on the exterior of beverage cans), lipstick and other cosmetics, inks, nylons, anticorrosive agents, and sealants. Castor production ceased in the United States in 1972, but CSRS

specialists worked with a group of farmers, agribusinesspersons, and users of castor to assess the prospects of reestablishing domestic production and processing. Lesquerella, a desert plant whose seed contains hydroxy fatty acids, has good prospects for farming and product applications.

Low-Input Sustainable Agriculture

Scientists in Georgia and Virginia have developed alternative methods of controlling fungal diseases and insect pests. Instead of relying on heavy preventive spraying to control the fungal diseases sooty blotch and flyspeck, they developed a postharvest technique for dipping the fruit in a household-bleach solution. This solution completely removes sooty blotch and reduces flyspeck by 73 percent. When sprayed fruit is dipped in the bleach solution, almost all the residues of fungicides are removed. Using this method, growers may eliminate up to eight sprayings of fungicide. Scientists have also found that major insect pests are effectively controlled by disruption with pheromone plus a single well-timed spray of insecticide. Alternative-row spraying and ground-cover management help to conserve the natural enemies of the pests and to reduce the need for sprays.

Enzymes Convert Food Waste to Ethanol

Researchers at North Carolina A&T State University have developed an enzymatic procedure to convert starch and lactose from food-processing wastes (such as bakery products, milling scraps, cookies, potato chips, and dairy products) to ethanol. This was done using a combination of fast-acting high-temperature enzymes. When cheese whey (which contains lactose) is cofermented with starchy wastes, the reduced processing time and cost will favorably affect the feasibility of converting biomass to alcohol.

Human Milk Processed and Stored

Some newborn infants with allergic sensitivities require human milk from donors when the mother cannot supply it. Human milk banks have increasingly been the source of supply for this milk. Food scientists at the University of Georgia have developed a procedure for the proper processing and storage of banked human milk. The procedure destroys the pathogenic bacteria while retaining the desirable constituents such as natural vitamins and antibodies. This information has been used in formulating Food and Drug Administration guidelines for the operation of milk banks in the United States.

Development of Scientific and Professional Expertise Is Nurtured

Since 1984, the National Needs Graduate Fellowships Grants Program has contributed significantly toward reducing the serious erosion of our national expertise in the food and agricultural sciences. The average graduate-record examination score of the 560 fellows supported by the program is more than 300 points higher than the average score of all graduate students in agriculture. For the sixth consecutive year, strengthening grants have been provided to the 1890 land-grant institutions and Tuskegee University to enhance their curriculum, faculty, instrumentation, and recruitment of outstanding students.

The 1890 Institution Capacity Building Grants Program was launched in FY 1990 to achieve three major goals: to strengthen linkages among the 1890 institutions, other colleges and universities, USDA, and private industry; to

advance cultural diversity in the work force of scientists and other professionals in the food and agricultural sciences by attracting and educating more minority students; and to enhance the quality of teaching and research programs at the 1890 institutions to more readily establish them as full partners in the U.S. higher education system in the food and agricultural sciences. The program is competitive and provides support to the 1890 institutions and Tuskegee University for teaching and research projects in targeted high-priority areas. The program encourages matching support from non-Federal sources and also requires cooperation with one or more USDA agencies in developing a proposal and carrying out a project.

The Higher Education Challenge Grants Program was initiated in FY 1990 to stimulate and enable colleges and universities to produce graduates capable of strengthening the Nation's work force of scientists and other professionals in the food and agricultural sciences. Projects in this program address (1) design of curricula and development of materials, (2) preparation and enhancement of faculty for teaching, (3) systems to deliver instruction, and (4) experimental learning for students.

A National Challenge Forum, "Forging New Partnerships To Attract Hispanic Talent to Careers in Agriscience and Agribusiness," was held to identify national initiatives and mechanisms for stimulating Hispanics to enter university-degree programs leading to careers as food scientists, agricultural scientists, and other professionals. A publication titled "Employment Opportunities for College Graduates in the Food and Agricultural Sciences, 1990-1995" indicates that college graduates with expertise in food, agricultural, and natural-resource disciplines will experience a strong employment market through the mid-1990's. An annual shortage of workers of nearly 11 percent is predicted for these fields.

NATIONAL AGRICULTURAL STATISTICS SERVICE

The National Agricultural Statistics Service (NASS) conducts research to improve the statistical methods and techniques used to produce agricultural statistics. This research is done in support of the NASS long-range program for improving the accuracy of crop and livestock estimates at minimum cost and is directed toward better sampling, yield forecasting, survey techniques, and quality assurance procedures. Some highlights of research accomplished in FY 1990 follow.

Satellite Data Used in Estimation of Crop Area

Satellite data may be used to improve techniques for estimating crop area. Data from U.S. Landsat and French SPOT earth-resource satellites were evaluated for estimation of crop area, using the extensive area frame ground-gathered data sample of NASS. The Landsat Thematic Mapper was chosen as the best sensor for large-scale inventories of U.S. crop acreage. Based on research of the last several years and starting in FY 1991, NASS plans to use Landsat thematic mapper data to improve the estimation of acreage of rice, cotton, and soybeans in the Mississippi River Delta region.

Computer-Assisted Stratification and Sampling

Area sampling frames are being developed through the use of digital earth-resource satellite data and U.S. Geological Survey digital map-boundary data. This research effort is a joint and cofunded project of NASS and the National Aeronautics and Space Administration (NASA). This project extends over 3 years (FY 1989-1991). NASA provides software support through the Ecosystem Science and Technology Branch located at Ames Research Center, Moffet Field, CA. The map and satellite data are displayed on a color graphics workstation, and the cartographer can draw primary sampling units on screen rather than using paper-based inputs such as Landsat prints, high-altitude photography, and county maps. Breaking up primary sampling units into sample segments will also be accomplished. These data are processed using onsite workstation-class computer systems. This will save substantial time and money because significant productivity gains will be seen with the new system. Computer-Assisted Stratification and Sampling (CASS) will also make it easier to update parts of State frames as needed. CASS is scheduled to be operational in FY 1991.

Interactive Editing Research on Surveys

A pilot study is being conducted on interactive editing research on several surveys, including corn objective yield, quarterly agricultural surveys, a survey on farm costs and returns, a farm report, surveys on crop variety and turf grass, and several others. A package called Blaise from the Netherlands Central Bureau of Statistics is the software of choice for this research. This software package provides the statistician with immediate feedback and control over the timing of edit processing instead of batch processing with timelags.

Geographic Information System

Geographic information system (GIS) technology is used to store, access, manipulate, and analyze spatial data sets and relationships. GIS may be thought of as a visual window or map of a database. Data inputs to a GIS might include earth-resource satellite data such as data from the Landsat

system; Census TIGER files of road networks; and agricultural survey data such as farm chemical data and agricultural production data that have been geographically referenced. NASS has been given the responsibility of building a GIS database as part of U.S. Department of Agriculture's Water Quality Program Plan to support the President's Water Quality Initiative. Research into other uses of GIS technology within NASS is also an objective.

Research on Estimation of Crop Acreage

Analysis has indicated that estimations of crop acreage provided by a quarterly probability survey are biased upward. The design of these surveys requires that the reported crop acreages correspond to the total acres operated by the farm operator. One hypothesis is that the farm operators cannot accurately report the total acres operated for their farm in a short telephone interview. A reinterview study was conducted in Indiana and Ohio in June 1990 to investigate if the bias could be reduced by more accurately defining the total acres operated. In a personal-visit interview, farm operators were specifically asked the number of acres owned, number of acres rented to others, and number of acres rented from others. Preliminary analysis indicated that the bias was significantly reduced by this change in the questionnaire. NASS has adopted the change in its operational quarterly surveys of crop acreage.

Forecasting Models of Corn Yield Improved

Forecasting models of corn yield previously used counts of ears and measurements of ear length. Analysis of data collected in Michigan and Missouri over 3 years indicated that incorporation of the measurement of ear diameter can improve the forecasting performance of the models. These additional measurements will be collected in all States starting in 1991 for the development of new forecasting models.

Research on Farm Costs and Returns Survey

A research project was conducted in Iowa and North Carolina to examine the scope and effect of data editing and missing data (refusals or inaccessibles) on the Farm Costs and Returns Survey (FCRS). Questionnaires were manually reviewed after the survey for changes due to editing. In addition, before- and after-editing values and reasons for editing were obtained for a wide range of survey items. The results of this research will demonstrate the type and volume of editing and imputation being done on the FCRS and their impact on estimates. These results may lead to future changes in the processes of survey editing and imputation.

A second research project was initiated to evaluate procedures for increasing the efficiency of area frame sampling by decreasing contacts with operations not qualifying as farms. Due to the length and complexity of the FCRS questionnaire, all FCRS data are collected by personal interview. Personal interviewing is expensive, even if the contacted operator is discovered during the interview to be out-of-scope for the survey. This project is designed to provide information on the characteristics of these nonfarm contacts. The information may form a basis for recommending alternative area frame sampling procedures that minimize contacts with nonfarm operators and thus yield more data per dollar spent.

ECONOMIC RESEARCH SERVICE

The Economic Research Service (ERS) was established in 1961 principally under the authority of the Agricultural Marketing Act of 1946 (7 U.S.C. 1621-1627). The mission of ERS is "to provide economic and other social science information and analysis for improving the performance of agriculture and rural America."

ERS produces economic and other social science information as a service to the general public and to help Congress and the Administration develop, administer, and evaluate agricultural and rural policies and programs. The wide range of topics covered by ERS includes

- U.S. and world agricultural production and demand for production resources, agricultural commodities, and food and fiber products.
- Costs of and returns to agricultural production and marketing.
- Economic performance of U.S. agricultural production and marketing.
- Effects of Federal Government policies and programs on farmers, rural residents and communities, natural resources, and the public.
- Organization and institutions of the U.S. and world agricultural production and marketing systems, natural resources, and rural communities.

ERS-produced information is made available to the public through research monographs, situation and outlook reports, standardized data products in electronic media, professional and trade journals (including The Journal of Agricultural Economics Research), magazines (including Agricultural Outlook, Farmline, National Food Review, Rural Conditions and Trends, and Rural Development Perspectives), radio, television, newspapers, and frequent participation of ERS staff at various public forums.

Food Prices Measured

ERS economists studied more than 300,000 item prices from 616 supermarkets representing 321 firms in 28 cities. The economists determined that prices differed because of level of capacity use, cost of store occupancy, number of special services offered, and market growth and rivalry in the stores' areas.

Futures and Options Markets Studied

In an ERS study, it was found that farmers can broaden their pricing alternatives and partly protect themselves against price declines within a production year but that the farmers will gain little stability of income from year to year by using futures, options, or cash-forward contracts.

Export Enhancement Program Evaluated

ERS findings indicate that the Export Enhancement Program (EEP) played a significant role in the exports of wheat and barley in FY 1990. The program assisted U.S. exporters by countering subsidies by competitors. The EEP boosted U.S. exports of barley and wheat; it also increased world market share and domestic producer prices for these commodities.

Trade Reform Reviewed	ERS found that agricultural policies in industrial countries have considerably distorted the world markets and that trade liberalization can have large benefits. ERS concluded that liberalization may also redistribute income and wealth within countries.
World Agriculture Analyzed	ERS calculated that during the past decade, agricultural production worldwide grew at an annual rate of 2.3 percent. However, per-capita food production worldwide rose only 0.5 percent because progress in North America, Europe, and Asia was partially offset by negative rates in Latin America, Africa, and the Middle East.
Markets in Developing Countries Hindered	ERS analysts concluded that many developing countries will increasingly depend on food aid rather than commercial imports because of lower economic and population growth, more rapid technological change in agriculture, and reduced environmental degradation. If 50 percent of the national debt is forgiven for Brazil, Chile, Mexico, and Venezuela, their agricultural imports would increase by $460 million. The U.S. share of that would be about 30 percent. If all debt were forgiven, U.S. agricultural exports would increase by $1.1 billion.
Farm Policies Studied	ERS research shows that the Federal Crop Insurance Corporation has been insuring high-risk farmers and that the premiums have not adequately reflected the risk. ERS estimated that under flexible planting options, soybean acreage would increase primarily in the Corn Belt and decline in the South, corn and wheat acreage would likely decline, farm income would be modestly affected, and prices of feed grain and wheat would rise somewhat and result in reduced deficiency payments.
European Community To Alter Trade in 1992	ERS research shows that the elimination of frontier controls and the establishment of fixed exchange rates within the European Community (EC) will reduce EC bulk exports. EC's internal and external trade in processed food products will increase.
Centrally Planned Economies Reviewed	ERS analysts found that consumers in centrally planned economies (CPE's) have been more heavily subsidized than producers. Past CPE policies constrained farm productivity, offsetting much of the financial support that producers received. These economies will continue to be net importers of agricultural goods in the near term. Over the longer term, CPE oilseed products and higher value specialty-product imports will increase. The CPE's may become net exporters of grains and meats in the next 5-10 years.
Changes Affecting Conservation and Environment Reviewed	ERS economists determined that commodity program changes can reduce agrichemical use and erosion while improving agriculture's market orientation and lowering cost to the Federal Government. New approaches in land retirement that are targeted at restoration of wetlands and change in land use can achieve long-term environmental improvements.
Federal Irrigation Water Affects Prices	ERS economists determined that changes in production of rice, vegetables, and fruit and nut crops could be large enough to affect national market prices.

A 10-percent reduction in the water supply would increase the price of rice by 4.6 percent and that of vegetables by 0.8 percent but would reduce fruit and nut prices by 3.3 percent.

Effects of Restricted Pesticide Use

ERS has estimated the following: The annual cost of banning is $50 million for carbofuran, $21 million for phorate, and $127 million for terbufos. Producers in California would have lost market shares relative to producers in other States and countries if Proposition 128 had passed. In North Carolina and South Carolina, the return to boll-weevil eradication was a continuous $0.97 per year for each public and private dollar invested (one time) in the eradication over the life of the program.

Rural Financial Markets Rated Healthy

ERS researchers found that rural banking firms successfully adapted to the presence of larger, urban-based banks and continue to serve the credit needs of rural borrowers. However, rural banks are not well suited to take advantage of proposals that would allow banks to enter new lines of business. As a result, rural businesses and communities may easily be put at a competitive disadvantage by deregulation of the product market.

Petroleum Shocks Affect Prices

ERS calculated that a crude oil price shock affects U.S. petroleum-based farm input prices directly (in the same direction) but with a muted effect (about 25 percent of the initial shock), and significantly influences these prices for more than 2 years.

AGRICULTURAL COOPERATIVE SERVICE

The Agricultural Cooperative Service (ACS) provides research, technical assistance, and information and education for the Nation's 4,799 farmer-owned cooperative businesses. The agency is the information source within Government for issues of policy, legislation, or regulation concerning farmer cooperatives.

Cooperatives' Income Second Highest in History

Farmer-cooperative statistics collected by ACS showed the net income of farmer cooperatives in 1989 at $1.85 billion, a 10.2-percent increase from $1.68 billion a year earlier. The 1989 figure is the second highest in history. The total net volume of business handled by cooperatives (excluding intercooperative business) was $71.1 billion, up 7.1 percent from $66.4 billion in 1988. Combined assets of farmer cooperatives rose 1.2 percent to $29.6 billion, compared with $29.3 billion a year earlier. Net worth was $13.3 billion, a significant 3.8-percent increase from $12.8 billion in 1988. The number of cooperatives decreased to 4,799 from 4,937 a year earlier.

Cooperatives Assisted by ACS Staff

ACS staff participated in 100 formal technical-assistance projects involving 116 cooperatives in FY 1990. Of these, 35 projects involved 51 existing dairy, livestock, grain, farm-supply, fruit, and cotton cooperatives. The other 65 projects involved emerging and developing cooperatives representing more than 2,700 producers of livestock, fruits, vegetables, honey, catfish, Christmas trees, nuts, timber, and crafts.

Cooperative Teaching Package Introduced

A self-contained course on cooperatives for secondary-school instructors was introduced by ACS educational staff members. The package contains everything needed by the instructor to teach a complete course on cooperatives. Included are lecture materials, activities, tests, overhead illustrations, reference materials, videotapes, and educational computer software.

Dairy Cooperative Reports Issued

Two ACS studies were issued: one on the marketing operations of dairy cooperatives and the other on the participation of dairy farmers in cooperatives. The former study was a periodic census of dairy cooperatives, the fifth in a series started in 1958. It includes a profile of the cooperative industry and a discussion of milk receipts and utilization, plant operations, dairy products marketed and cooperative market shares, methods of pricing members' milk, and incentive programs. The latter study documents the participation of dairy farmers in cooperatives through patronage and membership and through supply and marketing activities. It also explores other areas in which cooperatives may participate.

Report on Co-op Marketing in Asian Pacific Area Released

A report titled "Marketing High-Value Food Products in the Asian Pacific" was released by ACS in FY 1990. The report focuses on establishing and improving the working arrangements between exporters and foreign sales agents for the eight major Asian Pacific markets. The text examines the marketing of selected nonperishable food products and also describes channels of

distribution in the various countries. For the report, ACS conducted supermarket surveys of competing-brand products for their prices and packaging and then analyzed the results.

Report on Petroleum Cooperative Operations Available

A timely report, titled "Petroleum Cooperatives, 1988," was made available in FY 1990. This report examines the vital role of agricultural cooperatives in providing petroleum products to farmers and other persons in rural America. The text documents all aspects of cooperative involvement: from exploration for crude oil, acquisition of crude-oil and natural-gas supplies, and refining of crude oil, to the wholesale and retail distribution of refined petroleum products.

Cooperative Brands Widespread

Cooperatives reported using 991 different brands in their marketing of fruits, vegetables, dairy products, and farm supplies. About 84 percent of these brands are registered with the U.S. Patent and Trademark Office and are well known to most consumers. The report includes a listing of each brand, the cooperative that uses each brand, and the products marketed under each brand.

ANIMAL AND PLANT HEALTH INSPECTION SERVICE

The Animal and Plant Health Inspection Service conducts research and methods development to support its Animal Damage Control program through its Denver Wildlife Research Center (DWRC) at Denver, CO. The research is aimed at developing new knowledge necessary to resolve problems caused by vertebrate pests in America's agricultural production. Knowledge and tools resulting from this research are primarily used to reduce conflicts between wildlife and agriculture. DWRC works to transfer existing technology to broader uses in controlling damage by animals to agriculture. DWRC also collects scientific information to obtain new registrations of chemicals, to maintain existing registrations with the Environmental Protection Agency (EPA), and to develop nonlethal alternative tools for resolving problems caused by wild animals.

Research on Baiting for Coyote Control

The use of baits for selective coyote control potentially offers an inexpensive means of reducing predation on sheep and other livestock. Field and pen studies to determine coyote acceptance of small baits have been conducted in Idaho, Utah, and Texas. Physical and physiological marking agents were incorporated in baits to simulate the use of toxicants or other chemicals in the field. The use of new procedures for placing bait appears to result in a substantially higher percentage of coyotes finding and consuming baits than that in previous studies. Several methods used to reduce bait-take by nontarget rodents and birds warrant further evaluation. Current work seeks ways to reliably deliver baits to a higher percentage of local coyotes throughout the year, to define sources of variability in bait acceptance, and to determine whether coyotes that accept baits also kill livestock.

Modified M-44 Cyanide Ejector for Coyote Control

The M-44 is a mechanical spring-powered device designed to propel a lethal dose of sodium cyanide from a plastic capsule into the mouth of a coyote. The device, registered for use in coyote control in 1975, often malfunctioned due to caking of the cyanide formulation or corrosion of the ejector mechanism. The implementation of research findings on improved capsule seals, corrosion treatments, and handling procedures appears to have reduced these problems for field personnel. This has helped to increase the use of the device. A new color marker was added to the sodium cyanide formulation to replace the older material that EPA had identified as a potentially toxic inert ingredient. Laboratory and pen research was initiated to identify selective coyote attractants that could treat the device and extend its use during warm-season months (when coyote responses have typically declined). Field trials of several attractants have been initiated in Colorado, Montana, and Wyoming.

Development Continues of Blackbird-Resistant Sunflower Hybrids

The development of sunflower germplasm that is resistant to depredation by birds continued. Populations of plants possessing morphological traits that confer bird resistance were evaluated for bird resistance and agronomic traits at the Fargo campus of North Dakota State University and at five sites

in areas having high annual populations of blackbirds. Testcross evaluations indicated that good agronomic traits (high yield and oil) and bird-resistant traits (e.g., concave heads, long head-to-stem distance, and heavy bracts) can be combined into a hybrid. Preliminary tests are planned to evaluate future testcross hybrids for bird resistance at locations having large populations of blackbirds.

Sucrose Tested as a Bird-Feeding Deterrent

In a cooperative agreement with the University of Florida (Gainesville, FL), the feasibility of using sucrose (sugar) as a selective bird-feeding deterrent is being evaluated. Some species of birds are unable to digest sucrose and become ill if they consume a sufficient amount. Concurrent research by animal behaviorists and plant geneticists is under way. Animal behaviorists are determining the dose-response patterns of sucrose-tolerant and sucrose-intolerant birds in cage tests. Plant geneticists are examining a wide variety of cultivars to determine which produce high-sucrose fruits. Information from both disciplines will be used to assess the potential of sucrose as a bird deterrent in fruits.

Alpha-Chloralose Tested for Capturing Nuisance Waterfowl

Urban and suburban populations of geese, ducks, and coots can be nuisances and can cause many problems related to public health, airport safety, and damage. Laboratory and field trials were conducted to support the registration of alpha-chloralose (A-C) as an immobilizing agent for nuisance waterfowl. Incorporated into bread or grain baits, A-C causes waterfowl that ingest these baits to become immobilized. The target animals can then be safely and humanely captured for removal from conflict situations. Eight successful field trials were conducted in which unwanted waterfowl were removed from airports, golf courses, parks, and reservoirs.

Potential Repellants for Canada Geese

In 1989, a systematic strategy was developed toward registration of a compound to repel waterfowl from turf and agricultural crops. Subsequently, the chemicals methyl anthranilate (MA) and DRC-156 have undergone limited pen and field tests as potential Canada-goose repellants on turf. MA is a chemical used as a food additive and in certain industrial processes. Various aviary studies have shown that MA is an effective and safe taste repellant at concentrations of 1-2 percent. Studies evaluating the repellency of MA and DRC-156 to Canada geese after application to grass plots in an enclosure have shown that application rates of 8 and 15 pounds per acre, respectively, significantly reduce goose activity on those areas. Although both chemicals repelled geese at these rates, DRC-156 appears to offer much better repellency longer.

Cormorant Diet Impacts Catfish Industry

As part of a research project to determine the impact of double-crested cormorants on the catfish industry in the Mississippi River Delta, a study of the cormorant's diet was initiated in the winter of 1989-90. Cormorants were collected each month during the damage season (November through April) at catfish farms and roost sites in 1989-90 and at only roosts in 1990. Overall, the diet in 1989-90 was very similar to that in 1990, but differences in diet were seen between months and between sites of collection. From roost samples, catfish and gizzard shad were the primary

species of prey and composed 92 percent of the diet in 1989-90; catfish was 51 percent of that number. Cormorants collected at catfish farms in 1989-90 had a slightly higher percentage (64 percent) of catfish in the diet, and the percentage increased monthly from fall to spring. The reason for this pronounced trend is not clear, but it suggests that the greatest negative impact of these birds is in the spring. A similar but lesser trend in monthly diet was also seen for roost samples. Based on the measurement of catfish taken from cormorant stomachs, this impact is confined to catfish in size classes between 4 and 8 inches. Data on the diet of cormorants are being used, together with data on monthly roosting populations and energy-demand information, to project losses to the catfish industry from cormorant populations wintering in the Mississippi River Delta.

Reregistration of DRC-1339 for Control of Damage From Birds

A cooperative research program was begun to reregister the technical product DRC-1339 (Starlicide), a widely used avicide. Seven submissions of data were made to EPA in 1990, and nine more studies were initiated for submission during 1991 and 1992. In addition, studies were begun to determine whether blood-chemistry variables can be used to predict 1339-caused mortality in birds. These variables could be an important factor in assessing the mortality of pest and nontarget birds. In a field test, the treatment of raven eggs with 1339 was effective in eliminating predation by ravens on an endangered species, the California least tern.

Research on Livestock-Protection Collar Continued

Submissions of research and data continued in support of the livestock protection collar (LPC). Three product-chemistry studies were completed during FY 1990. In addition, required nontarget-hazards tests were completed and submitted to EPA. Muscle residues of the technical product 1080 from 10 coyotes killed in pen tests were analyzed, and estimates were made of the amount of LPC solution spilled onto the necks of collared lambs killed by the coyotes, to establish the potential nontarget hazards associated with the LPC. EPA originally required that 1080 LPC solution be applied to "simulated coyote kills" of sheep for primary-hazards tests with striped skunks and golden eagles. After much public opposition to these tests and a request from APHIS to delete these data requirements, EPA rescinded the data requirements for skunk and eagle testing.

HUMAN NUTRITION INFORMATION SERVICE

The Human Nutrition Information Service (HNIS) conducts applied research in food and nutrition. The agency compiles information on the nutrient composition of food, monitors the food and nutrient consumption of U.S. households and individuals, assesses consumer knowledge and attitudes concerning diet and health, and develops research-based dietary-guidance materials. HNIS also serves as the lead agency of the U.S. Department of Agriculture (USDA) for nutrition monitoring and implementation of the Dietary Guidelines for Americans.

Dietary Guidelines Revised

The third edition of "Nutrition and Your Health: Dietary Guidelines for Americans" was prepared jointly by USDA and the Department of Health and Human Services (DHHS) in FY 1990. The revised Guidelines maintain the seven principal messages of the earlier Guidelines published in 1980 and 1985. However, the new Guidelines suggest numerical limits for the intake of fat and saturated fatty acid; provide a new, interim method for assessment of healthy weight; and feature a more diet-oriented approach to guidance, including a guide to daily food choices. The revisions were based on the recommendations of the Federal Dietary Guidelines Advisory Committee. The Committee, established by USDA and DHHS in 1989, was composed of nine nationally recognized nutrition scientists and physicians. Their findings were published in May 1990 in the "Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 1990." HNIS provided staff support for the Committee.

Educational Campaign Continued

"Eating Right . . . The Dietary Guidelines Way," the ongoing HNIS nutrition education initiative, completed two waves of its campaign to promote the Dietary Guidelines for Americans and began the third wave of the campaign. The first wave featured four award-winning consumer booklets that show how to use the Guidelines in everyday situations such as food shopping, planning menus, choosing snacks, or eating out. The second wave introduced two new HNIS publications that address specific guidelines: "Good Sources of Nutrients" and "Calories and Weight." The third wave will feature the 1990 revision of the Dietary Guidelines for Americans. Major accomplishments include development of three press kits issued to magazines and newspapers nationwide; a broadcast-media initiative that reached a potential audience of nearly 17 million viewers/listeners; professional outreach programs for nutritionists, home economists, and health professionals; and an outreach targeting the Governor and Agriculture Commissioner in each State as well as Members of Congress.

"Calories and Weight" Published

"Calories and Weight, the USDA Pocket Guide" was published in a revised edition. The guide presents the calorie content of nearly 400 foods in a handy, easy-to-read format. It includes helpful information for either following a weight-loss diet or maintaining healthy weight.

Dietary Analysis Program Updated

USDA's Dietary Analysis Program (DAP), developed by HNIS in cooperation with the Extension Service for use by nutrition educators and consumers, was

updated to include the most current data on nutrients and the 1989 Recommended Dietary Allowances for nutrients. USDA's DAP software is available to the public from the National Technical Information Service and on the HNIS Nutrient Databank Bulletin Board. The existing software can be used with an IBM-PC and PC-compatible microcomputers. A version compatible with the APPLE II operating system is being developed.

Nutrient Data for Beef Updated

Revision and publication of Agriculture Handbook No. 8, "Composition of Foods," has been ongoing for the past several years. In 1990, HNIS issued the revised section on "Beef Products." The 1990 revision provides data for beef with one-fourth inch of outside fat removed and for beef with all outside fat removed, reflecting current marketing practices. Also published was the 1990 supplement to the handbook, which provides new information on dairy and egg products, breakfast cereals, fast foods, and several other types of foods.

Data on Vitamin K in Foods

A provisional table on "The Content of Vitamin K in Selected Foods" was published by HNIS. In addition, in cooperation with the Human Nutrition Research Center on Aging at Tufts University, Medford, MA, a project was initiated to analyze vitamin K in key foods. Interest in vitamin K has increased in recent years because persons treated with anticoagulant drugs need to monitor the vitamin K content of their food intake.

Food Composition of Pork Studied

Data from a Nationwide Pork Market Basket Study are being evaluated for use in updating USDA data on the composition of fresh pork. The data indicate that the fat content of most fresh pork cuts is lower than the values published in the 1983 edition of the Agriculture Handbook No. 8, section on "Pork Products." Updated data on the composition of pork will be included in the 1991 supplement to the handbook.

Analysis System Developed for Food Intake

HNIS is cooperating with the University of Texas School of Public Health (Austin, TX) to develop a food-intake analysis system for microcomputers (IBM-PC and compatibles). The system is an interactive, user-friendly dietary-analysis software package designed to assist in the collection, entry, storage, retrieval, and analysis of food-intake data. The database, drawn from the USDA National Nutrient Data Bank, contains over 6,000 food items and nutrient data for energy on 28 nutrients and other dietary components. The system is being marketed to professionals in research, education, and industry.

Continuing Survey of Food Intakes Conducted

The 1989 Continuing Survey of Food Intakes by Individuals (CSFII) collected data from two separate samples: a basic sample of 1,500 households from the general population, and a sample of 750 low-income households. All household members were asked to provide information on their food intakes for 3 consecutive days as well as sociodemographic data and general information on diet and health. Data collection for the 1989 CSFII has been completed, and the data are being compiled and analyzed. In 1990, the CSFII was conducted according to the same procedures with new basic and low-income samples. Data collection for the 1990 CSFII began on April 1, 1990, and proceeded according

to schedule. Plans for the 1991 CSFII are under way. A series of statistical reports summarizing the data from these surveys are planned.

Diet and Health Knowledge Survey Reported

The Diet and Health Knowledge Survey (DHKS) was initiated in 1989 as a telephone followup to the CSFII. For the DHKS, the main meal-planner/preparer in each CSFII household is requested to answer questions that assess knowledge about and attitudes toward diet and health. The 1989 DHKS has been completed and data analysis has begun. Preliminary findings from the DHKS have been presented at the 1990 Agricultural Outlook Conference and as part of several speeches at professional and scientific meetings. Data collection for the 1990 DHKS was begun in spring 1990 and proceeded according to schedule. Plans for the 1991 DHKS are under way. Two reports based on DHKS findings are being prepared.

Data From Food Consumption Survey Released

The 1987-88 Nationwide Food Consumption Survey (NFCS) collected data on the household use and cost of food for a 7-day period (household component) and on the intake of food by individual household members for a 3-day period (individual component). Data tapes for 3 days of dietary intake by individuals were released to the National Technical Information Service for public distribution. The tapes were also provided to the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), and the Federal Trade Commission.

Results of Bridging Study Presented

Compared to the 1977-78 NFCS, the 1987-88 NFCS made changes in interviewing and food-coding procedures as well as changes to update nutrient and recipe-file databases. These changes were assessed in the 1988 Bridging Study. For that study, a sample of nearly 700 women were surveyed using the methodology of either the 1977-78 NFCS or the 1987-88 NFCS. The study indicates that procedural changes had minimal effect on reported results when the 1987-88 and 1977-78 methods were compared. Results were presented at the 1990 Annual Meeting of the Federation of American Societies for Experimental Biology and other professional meetings. A report on the Bridging Study is planned for release.

National Nutrition Monitoring Report Planned

USDA and DHHS integrate findings from the components of the National Nutrition Monitoring System (NNMS) into combined reports to Congress. Data from USDA food-consumption surveys and the U.S. Food Supply Series are among the key sources of information for these reports. To date, two reports have been published--the first in 1986 and the second in 1989. Plans have begun for the third report. Information on the uses and usefulness of the reports and also ideas related to the focus and presentation of the data have been collected from professionals and policymakers who were users of the first two reports.

Collaboration on Pesticide Data Program

The Pesticide Data Program is a comprehensive, multiagency program of USDA in which data on the use of pesticides and the pesticide-residue levels in food will be collected and analyzed. HNIS, with the cooperation of EPA and FDA, is developing a Food Grouping System to translate data on foods as consumed

into a form that can be linked with pesticide-residue data. This process will allow assessment of the population's exposure to residues in food.

Home Food Cost Published

The cost of four USDA family food plans--thrifty, low-cost, moderate-cost, and liberal--was released monthly in FY 1990. The thrifty food plan is used as the basis for benefits in the Food Stamp Program.

AGRICULTURAL MARKETING SERVICE

Market research and development in the Agricultural Marketing Service (AMS) helps to minimize the cost spread between agricultural producers and consumers by finding new ways to increase food-marketing efficiency. The agency's research in this area encompasses three main efforts: (1) planning wholesale food distribution centers and farmers' markets to address specific facility problems hampering food marketing, (2) conducting method-improvement studies to increase the efficiency of specific food wholesaling and processing activities, and (3) identifying new market opportunities and related facility requirements to support expanded agricultural production directed toward opening additional sources of income for producers.

Central Refrigeration for Food Markets

The findings of a study comparing different kinds of refrigeration for modern wholesale food markets illustrate the importance of a new central-system design. This design consists of major machinery in a common engine room and refrigerant that is distributed to individual users through a network of pipes. Results of the study have been published in a joint report with the New York Department of Agriculture and Markets. Compared with individual refrigeration equipment on the facilities of each user, the central system reduces overall operating and energy costs. The new system also has an important environmental advantage: The large equipment in the central system can use alternatives to chlorofluorocarbons (CFC's), which may be detrimental to the environment.

Importance of Wholesale Food Markets Documented

Work has been completed on assessment of the importance of organized wholesale produce markets to agricultural producers of produce and ornamentals. Data were collected for this project through interviews with truck drivers using the Roadguard system maintained by the Florida Department of Agriculture and Consumer Services. Results of the study indicate that over 37 percent of all produce leaving Florida is marketed through wholesale food centers or produce markets. For example, more than 67 percent of produce moving to New York, NY, from Florida passes through the Hunts Point Food Distribution Center in New York. The study also illustrates the importance of a State system of farmers' markets as pickup points and, by inference, as outlets for local agricultural producers. Study results have been published in a report prepared in cooperation with the University of Florida (Gainesville, FL) and the Florida Department of Agriculture and Consumer Services.

Existing Marketing Facilities Being Improved

Efforts continue in the development of new ways to improve existing food centers as an alternative to establishing completely new markets at other locations. Under way are the following efforts: provision of technical support for the redevelopment of Central New York Regional Market at Syracuse, NY; long-range planning for Connecticut Regional Market, Hartford, CT; and new facility plans for New Bedford, MA. Some of these efforts feature the application of new building designs to older facilities to accommodate increasing business volumes and new food-handling technology. Other efforts involve the construction of new buildings. Study results have

been released in the form of limited-distribution reports, drawings, and technical consultations.

Major Urban Food Centers Are Planned

Researchers continue to evaluate the need for new marketing facilities to serve the region of Chicago, IL. Preliminary results indicate that over 1,700 wholesale food firms operate in the immediate city area, and about 450 of these firms may be located in areas where changing patterns of land use may force later relocation. Three other studies in advanced planning are evaluations of the potential development of new marketing facilities to serve South Carolina, Maine, and Ohio (Toledo). All four studies may involve activities to develop new facilities that will support local agricultural producers, regional wholesale activities, and movement of food products into international trade.

Simulation Studies of Traffic Management

Work is under way to develop improved methods of traffic management at modern wholesale food markets. In some of these markets, over 2,000 trucks, containers, and railcars may move into the market grounds in a single day. The management of parking and street traffic to accommodate these delivery and transport vehicles is a major challenge. The dynamic nature of this traffic movement compounds the difficulty of developing solutions and improved methods. Simulation techniques will be used because they are an attractive method of trying many different alternatives before adopting a particular plan for a market.

New Facilities Planned for Hunts Point Food Distribution Center

Working cooperatively, AMS and the New York Department of Ports and Trade have developed plans for new meat-marketing facilities at the Hunts Point Food Distribution Center, New York, NY. These new facilities will accommodate firms that may be displaced by changing patterns of land use in Harlem. Study results have been published in a joint report of USDA and the city of New York. In addition, specialists have provided technical and other assistance in developing overall long-range plans for the Hunts Point Food Distribution Center, one of the largest food centers in the world.

Export Test Shipments

In cooperation with the International Marketing Program for Agricultural Commodities and Trade (IMPACT) Center at Washington State University (Pullman, WA), test shipments are being conducted in the Pacific Rim countries with products from Washington and Oregon. A survey was conducted of wholesale and institution buyers in Japan with Walla Walla onions to obtain market acceptance and to disseminate information about uses of the product. Based on the favorable reaction of the buyers, test shipments will be conducted in summer 1991 with small quantities of onions transported under various conditions, including in several types of containers. The shipments will be evaluated by an IMPACT representative in Japan; if satisfactory results are achieved with any conditions/containers, larger shipments will be sent. The IMPACT Center has worked with packers in shipping other products such as asparagus, cherries, sweet corn, beef, and snow peas. All of these are shipped by air, but test shipments by surface are planned for some of these products.

Horticultural Producers Federation

The Horticultural Producers Federation is an association of 14 small marketing cooperatives in six Southeastern States, representing about 1600 farmers. The Federation was created to facilitate centralized marketing, procurement, and data-management systems to enable the cooperatives to more effectively compete in producing and marketing fresh produce. Of the original 16 member cooperatives, 5 have gone out of business (but 3 others have joined). In 1990, the Federation had gross sales of $2.15 million from the sale of tomatoes, peppers, squash, cabbage, and cucumbers. Gross sales in 1989 were $1.77 million. Production was good in 1990, but prices were down. During the year, one member cooperative built a new packing facility at a cost of $2.5 million, another cooperative acquired funding for a new facility, and another was in the process of getting funding from a State government. The State of Virginia bought the facilities of one of the member cooperatives, and the board of directors of the cooperative is operating it as a farmers' assembly market, where the product will be sized, graded, cooled, and packed.

Reducing Imports of Melon Balls

The U.S. imports $11 million worth of melon balls annually, but the product is reported to be very low in quality and sweetness. The United States does not export any melon balls. AMS and Oregon State University (Corvallis, OR) are developing methodology and equipment for mechanically producing melon balls from supersweet Japanese melons. Farmers in the Hermiston, OR, area have been producing supersweet Japanese melons for several years and plan to produce enough for the domestic and international consumption of whole melons and melon balls. The manual method of producing melon balls is labor intensive and may injure the wrists of workers, so it is essential that equipment be developed to automate the production of melon balls.

Draft Uniform Product Codes Completed

The Produce Electronic Identification Board (PEIB) is an industry group formed by a joint effort of USDA, United Fresh Fruit and Vegetable Association, and Produce Marketing Association for the purpose of facilitating the scanning of all types of produce purchases. PEIB has completed work on a list of standardized price lookup numbers (PLU's) and variable-weight uniform product codes (UPC's). This list is the result of discussions with representatives of the produce industry, including growers, shippers, packers, commodity groups, and retailers. Before adoption by the produce industry, the list was submitted to the UPC Random Weight Ad Hoc Committee and the Uniform Code Council for approval. Although the adoption of any new standard codes is expected to be a slow process, the fixed-weight codes are beginning to appear on supermarket shelves. Adoption of standard PLU and random-weight codes will give retailers the capability of tracking the sales of produce and also of performing market analyses for produce in a manner similar to those for other products such as dry and frozen foods. The use of these codes will speed up the checkout process and will greatly reduce product-identification errors by cashiers.

OFFICE OF TRANSPORTATION[1/]

The mission of the Office of Transportation (OT) is to help develop an efficient agricultural transportation system that will improve farm income, expand exports, and meet the needs of rural America. OT provides technical and administrative direction, coordination, and leadership in the development and execution of the agricultural and rural transportation policies and programs of USDA.

Technical Assistance to Eastern Europe

OT's Technical Business Assistance Group funded a series of OT workshops throughout Poland. The workshops covered the proper postharvest handling, transportation, and marketing of perishable products and livestock. The primary audience was Polish farm leaders, transporters, entrepreneurs, and government officials who would later train other persons. Other teams led by OT have contributed onsite technical assistance to Polish efforts to improve the wholesale food-marketing system in that country. Technical support to date has included evaluations of facilities and methods and also training seminars for local planners and food-industry managers. Additional planned and proposed work includes technical support and detailed engineering studies for facilities designed to meet local food-marketing requirements in Bulgaria.

Restriction of Container Use Denied

The Federal Maritime Commission (FMC) denied two petitions filed by two ocean carrier conferences and the American Trucking Association. The carriers had requested that the FMC initiate rulemaking to establish maximum weight limits of containers and to eliminate per-container rates for certain commodities to reduce the incidence of allegedly overweight containers on highways. OT filed comments on the issue on behalf of USDA and exporters of forest products, animal feeds, leather hides, and other agricultural commodities. Over 26 agricultural shipping and commodity trade associations also filed comments. The principal concerns about such rulemaking were the resulting reduction in competition, increase in freight costs, and reduction in U.S. exports.

U.S.-Andean Agribusiness Workshop

At the request of the Office of International Cooperation and Development, an OT staff member spoke to government and private-sector representatives from Bolivia, Colombia, Peru, Ecuador, and Venezuela about the importance of maintaining product quality during transportation. The presentation was part of a U.S. Department of Transportation-sponsored workshop in support of the President's Andean Initiative to counter the illegal production and trafficking of drugs. OT developed slide presentations, tip sheets, and popular handbooks that can be used to train Andean farm managers, shippers, carriers, and receivers in handling perishable goods. One handbook is available in Spanish; it was translated and printed by the Agency for International Development for the Caribbean Basin Initiative in 1988.

[1/]Editor's note: Pursuant to Secretary's Memorandum 1030-25, the Office of Transportation and its functions were transferred to the Agricultural Marketing Service on January 1, 1991.

Trade Team Visits Soviet Union

Under the Agricultural Economic Research and Information Protocol in the Field of Agriculture, the United States sent a delegation to the Soviet Union to study the economic aspects of consumer-ready foods. OT was part of the team that traveled for 2 weeks in the Soviet Union. Overall objectives of the team's travel were to (1) review Soviet regulations on the importation and distribution of consumer-ready foods, (2) report on the economic structure of the Soviet food-processing industry, (3) document food-safety standards (labeling requirements) for processed foods, and (4) document current food-distribution methods and report changes in the system that will assist U.S. exporters in transporting their products in the future. OT was responsible for completing the objective regarding distribution.

Export Directory for Shippers

OT completed a transportation services directory for exporters of perishable agricultural products. The directory provides basic information on refrigerated transport equipment that is used by air, ship, and rail carriers serving exporters of perishable goods. The directory also provides a listing of over 200 carriers serving the export industry.

Tips on Export Shipping

OT completed a tip sheet on shipping baby chicks and hatchery eggs for export. More than $100 million worth of baby chicks and hatchery eggs are exported annually. Both products are highly perishable and subject to high losses if not handled and transported with the utmost care.

Grape and Strawberry Research

OT presented results of research on reducing transportation damage to fruit at the annual meeting of the American Society of Agricultural Engineers. This research centers on grapes and strawberries, which receive more than $18 million worth of shipping damage each year. Most of this damage is caused by vibrations entering the load through the truck suspension. OT research determined the frequencies that cause the damage, and this information was used to redesign truck suspensions and fruit packaging.

Assessment of Argentine Infrastructure

OT, in conjunction with the Economic Research Service and Foreign Agricultural Service, completed a visit to assess Argentine transportation and distribution facilities. Argentina is a major competitor of the United States in world markets of oilseed and oilseed byproducts. An inefficient transportation system represents a significant portion of Argentine product costs. However, the Argentine Government is in the process of privatizing some of the most important lines of distribution, which may affect Argentine participation in the world market in the future.

Kansas Rail Abandonments Studied

On June 30, 1990, almost 700 miles of Kansas rail lines were designated either "under study for abandonment" or "anticipated to be abandoned within 3 years." Focusing on 480 miles of these lines with an abandonment status of category 1, OT conducted a study to assess the direct economic impact of these abandonments on the agricultural and rural communities of Kansas. The study estimates that approximately $2.3 million would be lost annually in terms of decreased farm income, increased costs from road damage, and lost property-tax revenue.

OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

The mission of the Office of International Cooperation and Development (OICD) is to coordinate international cooperation in agriculture and related fields.

International research and education programs include scientific and technical exchanges, management of collaborative research, representation of the U.S. Department of Agriculture (USDA) and U.S. Government research and education interests in international organizations, and training and facilitation of private sector involvement in agricultural development and cooperation. Programs are conducted cooperatively with other USDA and U.S. Government agencies, universities, and the private sector.

Benefits of International Collaborative Research Shown in Apple Rootstocks

For 30 years, uninterrupted research between the United States and Poland contributed to the commercial production of apples for both countries and to the preservation of apple germplasm. The Research Institute of Pomology and Floriculture at Skierniewice, Poland, evaluated thousands of varieties and clones of apple for genetic characteristics such as dwarfing, winter hardiness, and resistance to disease. The collaborative research for USDA was carried out by researchers of the Agricultural Research Service, Cornell University (Ithaca, NY), and the North Central Regional Project (conducted by State agricultural experiment stations of the region).

Five rootstock clones were introduced into the United States from the Polish breeding program and released to commercial breeders. From this original introduction to the United States, rootstocks P-2 and P-22 have shown the most promise for apple production and have been commercially available since 1985. The Polish rootstocks have excellent dwarfing characteristics and have played a significant role in the shift to smaller trees in U.S. commercial orchards. Smaller trees reach commercially acceptable yields in fewer years after planting and produce a greater yield per acre (because more trees can be grown on an acre of land). Other important characteristics of the Polish rootstocks include cold hardiness and heavy productivity when grafted with favorite U.S.-market varieties. The availability of the rootstock in the United States proved to be of unusual benefit to Poland after it lost 40 percent of its apple trees during a severe winter freeze in 1987. Ordinarily, it would have taken 10 years to produce enough rootstock to replace those trees. Because of this project, a private nursery in the United States was able to supply 1 million apple rootstocks that had been propagated from the original Polish rootstock. This project illustrates the benefits of international collaborative research and the preservation of plant genetic resources.

Sour Cherries: A Crop at Risk

The entire $56 million sour-cherry industry in the United States is based on the monoculture of a 400-year-old cultivar thought to have originated in the Montmorency Valley of France. Seventy-five percent of the U.S. sour-cherry crop is geographically concentrated in Michigan. The Montmorency cultivar is vulnerable to two fungal pathogens: One destroys the leaves and the other

attacks blossoms and fruits. So the potential exists for an epidemic of plant disease.

Growers of the sour cherry use multiple applications of costly chemical sprays to control leaf defoliation and to prevent blossom and fruit rot. But the cost of agricultural chemicals is rising, currently available fungicides may be banned, consumers worry about chemical residues in food, and concerns are growing about groundwater contamination and other damage to the environment from agricultural chemicals.

Fortunately, genetic diversity and disease resistance do exist among the naturally occurring cherry trees in the backyards and along the roadsides in Hungary, Romania, and other Eastern Europe countries. In 1983, Michigan State University (East Lansing, MI), using collaborative research funds from OICD and the National Academy of Sciences, began an extensive collection of sour-cherry germplasm in Romania, Hungary, Poland, Yugoslavia, and Bulgaria.

Researchers at Michigan State University are now evaluating these collections for disease resistance, cold hardiness, fruit quality, and other economic traits. OICD plans to support additional collaborative research between Michigan State University and Hungary Enterprise for Fruit Growing and Ornamentals. Scientists hope to identify individual disease-resistant trees to introduce them as possible replacements for the vulnerable Montmorency. Other trees will be introduced into U.S. breeding programs. Finally, scientists are using molecular markers to identify individual genes or groups of genes to eventually control the diseases that threaten the U.S. sour-cherry industry.

Sunflower Bonanza

As recently as 1966, American farmers grew only 6,000 acres of sunflowers for oil-seed production. Sunflowers were a relatively minor crop and were grown in only special situations. Since then, sunflower production has almost exploded as a major cash crop in the Dakotas, Minnesota, Texas, and Kansas. In 1990, the United States will harvest 2 million acres of sunflowers. The crop will include 250,000 acres of confectionery sunflowers with a farm value of $41.3 million. The oil-seed harvest will cover 1,750,000 acres in major producing States. The value of the 1990 oil-seed crop is estimated at $24.6 billion.

Eastern European farmers, particularly those in Yugoslavia and Romania, have grown sunflowers for many years. Their crops had genetic variability that was unavailable in the United States. More than 20 years ago, USDA scientists in cooperation with North Dakota State University (Fargo, ND) began using U.S.-owned foreign currency to collaborate with Yugoslav scientists to collect, collate, and evaluate sunflower germplasm. Their work continues today.

American and Yugoslav scientists are carrying out joint explorations for germplasm. They are cross breeding lines from the United States and Eastern Europe with material from collecting trips in those regions. U.S. scientists

bring in promising germplasm from Yugoslavia for further screening. U.S. scientists have found genetic traits for larger and heavier seeds, resistance to virulent plant diseases, and highly unsaturated cooking oils. They have also found a new genetic source for restoring cytoplasmic male sterility; this capability will be a valuable device in the arsenal of plant breeders.

Over the last 20 years, USDA and the North Dakota State Experiment Station have released several promising breeding lines of the Yugoslav material to 11 U.S. seed companies and numerous researchers. The releases have become so intermingled with other breeding lines and with commercial releases that they are impossible to trace with any precision. This situation is desirable. But it may be stated that the U.S.-Yugoslav germplasm is still contributing in substantive ways to the sunflower bonanza.

FOREST SERVICE

Forest Service (FS) research is conducted at eight regional experiment stations and at the national Forest Products Laboratory in Madison, WI. More than 2,800 studies, involving approximately 750 FS scientists at 74 locations throughout the world, are conducted at any one time. FS scientists published 2,165 research papers in 1990. The integrated research program is aimed at improving environmental quality, resource productivity, and management on America's 1.6 billion acres of forests and associated rangelands.

Research on Global Change

FS research shows that high-elevation forest ecosystems in the Rocky Mountains and the Sierra Nevadas are affected by variability of climate and air-pollution stress. Scientists have shown that atmospheric variability determines winter-snowpack variability, timing and composition of spring runoff, level of salmonid populations, and susceptibility of trees to damage (from unusual temperature variations if exposed to certain air pollutants). Scientists have developed computer simulations to predict the increased potential for forest fires caused by changes in long-range weather patterns and climate.

The Forest Response Program ended in 1990. Highlights of conclusions from the 6-year program are as follows:

- Air pollution is adversely affecting trees in much of the Sierra Nevadas in central and southern California, and the damage is more widespread than previously thought.
- Highly acidic cloud water is damaging high-elevation red-spruce forests in the Eastern United States.
- Most forests in the Eastern and Western United States are not showing damage that is attributable to current levels of acidic precipitation or ozone.
- Ozone may be impairing the growth of some southern-pine forests.
- Changes in soil chemistry from acidic deposition have been observed along four regional gradients of sulfate deposition in eastern hardwood forests.
- Tree physiology and growth models indicate that natural tree variability can mask responses to air pollutants, that physiological processes may compensate for damage from pollutants, and that effects of pollutants are manifest through a number of mechanisms.

A Forest Health Monitoring program was initiated in 1990 to study long-term productivity, health, and diversity of the Nation's forests. First-year efforts include the design and establishment of a plot network to quantify tree-growth rates, tree vigor, stand composition, landscape characteristics,

insect and disease occurrence, climate change, atmospheric pollution, and other direct anthropogenic stressors to the forest.

Research on Threatened, Endangered, and Sensitive Species

The recovery of threatened, endangered, and sensitive species requires cooperation and effective partnerships. Researchers at the Pacific Northwest Station have formed the Rare Plant Consortium with 22 cooperating institutions to develop management guidelines for rare and endangered plants. A partnership of FS and The Nature Conservancy produced policy, management guidelines, and research and development for protecting and enhancing biodiversity.

FS manages lands in western Oregon and Washington and northwestern California that contain 71 percent of the remaining habitat (5.1 million acres) of the northern spotted owl. Pacific Northwest Station researchers measured the abundance and diversity of spotted-owl prey in the Mixed Conifer Zone of southwestern Oregon, the Western Hemlock Zone of the Oregon coast ranges, and the Western Hemlock Zone of the Olympic peninsula in Washington. The diversity and total biomass of major prey species decreased markedly from southwestern Oregon to the Oregon coast ranges and from the coast ranges to the Olympic peninsula.

Research on Atmospheric Sciences and Forest Fires

Atmospherically deposited sulfur is accumulating in soils and wood in northern forests. Sustained accumulation may lead to the loss of essential growth nutrients, such as calcium, magnesium, and potassium, and may increase soil acidification, thereby reducing forest growth. New computer models were developed to better predict the effects of spotting and crown fires. FS scientists are helping planners, local fire departments, and homeowners cope with catastrophic wildland fires in the wildland-urban interface.

FS research on the natural role of forest fires helps to reduce the costs of fire suppression and protects lives and property. A "home risk meter" translates fire-research findings into a format accessible to homeowners so they can identify and correct risk factors.

Research on Forest Insects and Diseases

FS research is providing an array of biological alternatives to chemical pesticides, including natural enemies for controlling insect pests or noxious weeds, microbial agents, and semiochemicals (naturally occurring compounds that guide insects to a mate or suitable host). For example, the larch casebearer, a major defoliator of western larch, has been reduced to nonpest status by the successful release of a parasite. Scientists have significantly improved the field efficacy of the environmentally safe bacterium Bacillus thuringiensis (Bt) for controlling the gypsy moth. In 1990 tests of a new aerial application procedure, Bt was found to cover 98 percent of the leaves. Significant advances were also made in the control of mountain pine beetles, termites, brown rot, oak wilt, western gall rust, and other pests and diseases.

Research and Analysis of Forest Inventory

In 1990, FS developed measures of national-forest productivity for softwoods and hardwoods for a 35-year period (1952-1987). Measures of productivity are

based on timber inventory, timberland area, net annual growth, and annual data on timber removal. While the quantity of softwood timber capital (volume or inventory of timber-growing stock on timberland) remained relatively constant over this period, the productivity generally improved for all regions, except for decreases in growth and inventory in the South and North and decreases in removals and inventory in the North.

Economics Research on Renewable Resources

The Forest Products Laboratory found that accelerated recycling will have a substantial impact on timber markets. Pulpwood needs will grow more slowly as the amount of wood pulp consumed per ton of paper drops a projected 14 percent due to increased use of wastepaper. Projected price increases for pulpwood and sawtimber in all regions will be substantially reduced.

In 1990, research also provided savings of $200,000 in computing costs to national forests in the Pacific Northwest. This savings was realized in only 2 months as a result of an economical alternative to running forest-planning analyses on mainframe computers. Another database development allowed the management of large datasets for quantifying tradeoffs among regional outputs. Using this system, analysts were able to demonstrate the effects of regionwide forest management on forage, wildlife, and water production in the South.

Research on Urban Forest and Recreation

A survey of householders in 8 cities produced a ranking of 10 tree species commonly planted on city streets and also a list of the benefits and annoyances that residents experienced from each tree species. Urban foresters are using this information to select trees that will be the most enjoyable to residents.

Models developed for the evaluation of choices of recreational sites show that trees and other natural features were one of the most important factors influencing people's choice of sites. These models are being used to predict how users will respond to changes in the physical and social environments of the recreation sites. For example, visitors viewing ponderosa-pine forests indicated a willingness to pay for camping in parklike stands of large trees with a minimum of downed logs and dead trees.

Research on Forest Management

Forest Service Research and the National Forest System are developing standards for monitoring the quality of soil at sites in Louisiana and California. The work will be expanded to other regions of the United States and possibly to Canada, New Zealand, and Australia. The network of installations and the climatological data collected can be used in research on the effect of climate change on forest processes.

International Forestry

FS international activities are conducted in cooperation with other Federal agencies, nongovernmental organizations, the United Nations, and other international organizations and through bilateral arrangements with other countries. In 1990, FS personnel participated in 16 scientific and technical exchanges with 11 countries on subjects ranging from the atmospheric effects of tropical forest burning to genetic resistance by tree species.

International Forestry participated in 23 cooperative research projects in 5 countries under the Special Foreign Currency Program (Public Law 480).

Tropical forestry research and technical assistance were undertaken with the United Nations' Food and Agriculture Organization, Mexico, Brazil, and 30 other countries. Outreach in the Caribbean and the Pacific Islands included a tree-planting guide and training course, forestry newsletters, conferences for foresters, and assistance in rehabilitation after hurricane damage. The Forestry Support Program assisted developing countries by reducing the deterioration of natural resources and by increasing the sustainable use of forest resources. Workshops supported by this program were held in Africa, Asia, and Latin America.

FEDERAL GRAIN INSPECTION SERVICE

The Federal Grain Inspection Service (FGIS) conducts applied research in the process of fulfilling its mandate to administer the Nation's grain inspection and weighing system. FGIS is an action-oriented agency with responsibilities to develop (1) new or improved methods and equipment for grading, inspecting, and weighing grain; (2) inspection standards; (3) inspection and weighing procedures; and (4) other grain-marketing services and programs. FGIS and the Agricultural Research Service (ARS) cooperate in establishing policies, responsibilities, and procedures for research in assessing grain quality. The Director, Quality Assurance and Research Division, shares with the FGIS Administrator the ultimate responsibility for overall planning, research, and related support programs and activities assigned to FGIS.

FGIS manages research outside the agency by reimbursable agreement with ARS or by contract with any acceptable vendor through the contracting capability of the Animal and Plant Health Inspection Service. Projects for which the personnel and equipment are available or reasonably obtained are handled within FGIS.

Testing for Aflatoxin

FGIS continued to integrate fast, accurate, and safe methodologies of aflatoxin testing into the national inspection system. In 1990, the agency initiated an evaluation of commercially available aflatoxin test kits, which report the actual parts per billion of aflatoxin present. These kits were also evaluated for their ability to measure aflatoxin in processed grain products and in grains other than corn. This study augmented a similar evaluation conducted in 1989, which resulted in FGIS approval of six test kits that provide qualitative results as screening methods in the national inspection system.

Analysis of Corn Quality

In an effort to provide information on quality to buyers and sellers of U.S. corn, FGIS is developing near-infrared reflectance (NIR) techniques for measurement of the protein, oil, and starch contents of corn. FGIS hopes to use the same whole-kernel NIR instrument that is currently approved for the analysis of soybean protein and oil.

Study on Cleaning Grains

As part of its continuing effort to evaluate how grain standards interact with the marketplace, FGIS has engaged the Economic Research Service to conduct a study to determine the economic feasibility of cleaning grains. The study will address corn, barley, sorghum, soybeans, and wheat and is expected to be completed in approximately 3 years.

Control of Grain Dust

Recirculation of grain dust at export grain-handling facilities may present health hazards to grain handlers including the potential for explosion. The grain dust may also lessen the quality of grain for export. FGIS funded research to evaluate the costs and benefits of retrofitting export elevators to prevent recirculated grain dust from being returned to the grain stream at export elevators.

Detector for Grain Odor

Grain odor is an indicator of grain quality. At present, grain odor is determined by subjective tests conducted by inspectors. FGIS is working with ARS to produce a simple mechanical "sniffer" that objectively detects odors in grain. The study has produced promising results. FGIS is analyzing both sound grain and grain containing odor to determine the chemical compounds that cause specific odors. Many odors listed in the current grain standards (such as "sour" or "musty") can be attributed to the presence of specific chemical compounds in the grain. Commercially available odor sensors have been purchased and are being evaluated for their ability to detect grain odors.

Image Analysis for Food Defects

Advances in computer technology have allowed the increased use of image analysis in the inspection of a wide variety of food products. In this technique, items are examined for defects using a camera system linked to a computer. The type and amount of damage can be determined. FGIS is supporting research by ARS to develop this technology as an important tool for use in the official inspection system.

Measurement of Insect Infestation in Grain

FGIS continued to support research to measure levels of insect infestation in grain. The enzyme-linked immunosorbent assay (ELISA), which detects small amounts of insect-muscle protein, measures total infestation including live and dead insects. ELISA test results correlate with standard analytical techniques such as counts of insect fragments and counts of insect holes in kernels. FGIS, in conjunction with ARS, is also developing an acoustical detector that measures the number of live insects present in a sample of grain.

Mycotoxin Test Kits Evaluated

Mycotoxins are toxic substances produced by a wide variety of molds. Aflatoxin is the most publicized mycotoxin, but others may also present problems to grain. FGIS worked with mycotoxin experts from the Food and Drug Administration (FDA) and ARS to determine the relative levels of several mycotoxins. Preliminary studies were carried out to determine the ease of use and the performance capabilities of commercially available test kits for deoxynivalenol (vomitoxin), T-2 toxin, ochratoxin, and zearalenone in grain.

Analysis of Pesticide Residues in Grain

FGIS is developing a program for the measurement of pesticide levels in U.S. grains. In an effort to use techniques that are faster and safer than conventional techniques, FGIS purchased a supercritical fluid-extraction apparatus that extracts pesticide residues from samples using liquefied carbon dioxide at high pressure. Use of this technique takes minutes, rather than hours, and lowers analysis costs by approximately 90 percent. FGIS is working with ARS to develop the proper extraction conditions for recovering pesticide residues from grain samples.

Measuring Sprout Damage in Wheat

Sprout damage in wheat is currently measured by the Falling Number test. FGIS is comparing the Falling Number test with the Stirring Number test (a technique developed in Australia) to determine which method provides the more reproducible results. Both techniques indirectly measure the amount of sprout damage in wheat. The Falling Number test measures the length of time

required for a metal plunger to fall through a viscous starch solution. The Stirring Number test measures the resistance to stirring a propeller in a similar solution.

Toxicity of Weed Seeds Evaluated

FGIS, with ARS, has evaluated the toxicity of jimson weed, morning-glory, velvetleaf, and sicklepod. The information will be reported to FDA for a determination of whether defect action levels will be established for these weed seeds in grain. FGIS is still analyzing the toxicity of black nightshade.

Wheat Classification System

FGIS, ARS, the Agricultural Marketing Service, and the industry-sponsored Wheat Classification Working Group are working to develop a wheat-classification system based on objective test results rather than on color and morphology of the kernel. Wheat-hardness information is potentially valuable to processors and handlers and may provide a basis for classifying wheat. In 1990, FGIS initiated a field study to evaluate the variability associated with the near-infrared reflectance (NIRR) method for determining wheat hardness. The agency analyzed approximately 12,000 wheat samples using both single-kernel hardness testers and NIRR instruments. To provide a basis for evaluating the variability of hardness-testing data, FGIS is developing a standard reference method for measuring the hardness of a single kernel of wheat.

EXTENSION SERVICE

The Extension Service is the Federal partner in the Cooperative Extension System (CES). CES is a national network that helps people improve their lives through an educational process that uses scientific knowledge focused on issues and needs. With guidance developed through strategic planning and issue-based programming, national initiatives and base programs are developed and delivered in ways that make a difference in the lives of the people. The educational process is interactive, involving people at the grassroots and the State and Federal levels in issue identification, priority setting, program delivery, and impact assessment.

Extension is building its forward-looking programs on a long history of program development based on sound educational theory and successful practice. In its nationwide network with offices in nearly every county, CES combines the resources of Federal, State, and local governments, and works with other public and private agencies to carry out nonformal education. More than 15,000 professionals and support staff, augmented by nearly 3 million volunteers, are involved in these efforts.

National Initiatives

Contemporary society--agricultural, rural, and urban--is buffeted by forces of change at the farm, business, family, community, regional, national, and global levels. These forces generate the issues that Extension addresses through its national initiatives. National initiatives are identified through a strategic planning process, developed and approved by CES leadership, and implemented across CES wherever the educational need exists. New initiatives may be developed at any time while existing initiatives may be phased into ongoing base programs. This dynamic process results in initiatives that consistently target emerging issues, and the number and focus of initiatives change over time.

In 1990, CES focused on issues critical to American society through seven national initiatives: Sustainable Agriculture, International Marketing, Water Quality, Food Safety and Quality, Waste Management, Revitalizing Rural America, and Youth-at-Risk.

Sustainable Agriculture

Sustainable agriculture has been established in CES as site-specific agricultural systems that are resource efficient, economically feasible, environmentally sound, and socially acceptable. Through this national initiative, educational programs assist the development of these systems. Activities in 1990 encompassed the development of whole-farm decision-support systems such as PLANETOR that evaluate the economic and environmental aspects of production alternatives. Data banks and information-delivery systems are available to identify combinations of resources that increase productivity while protecting the environment and meeting societal concerns.

International Marketing

The International Marketing initiative is increasing rural business owners' awareness of international marketing opportunities, helping producers assess the location and extent of foreign-market potential for U.S. products, and

alerting producers and processors to opportunities for adding value to U.S. products for export. Information centers are effective in identifying export opportunities for local businesses, and planning is under way for expanded program development and cooperation with other agencies.

Water Quality

The Water Quality initiative is a large nationwide initiative that conducts educational programs to assist agricultural producers in reducing/preventing water degradation due to plant nutrients, pesticides, and animal wastes. This initiative enables households to identify and protect/improve the quality of their well water and facilitates citizen actions to improve the quality of water from public water systems. In cooperation with the Soil Conservation Service and the Agricultural Stabilization and Conservation Service (ASCS), and with special Federal funding of $10.375 million, the following have occurred:

- Projects have been established in 16 States across the Nation to demonstrate state-of-the-art agricultural production practices and cost-effective systems that reduce loadings of agricultural nonpoint-source contaminants.
- Seventy-four nonpoint-source hydrologic unit areas have been established to address water-resource impairments resulting from agricultural nonpoint sources.
- Accelerated education programs have been implemented in all 50 States to enable agricultural producers and rural residents to adopt management practices for agrichemical and animal waste to reduce and prevent contamination of ground and surface water.

Food Safety and Quality

Through the Food Safety and Quality initiative, Extension clientele are improving practices and processes that promote the production and protection of the food supply with minimal risk. They are improving their understanding of risks and are adopting recommended food-handling practices. The Hazard Analysis and Critical Control Points system is being adapted by Extension in programs for producers, processors, and consumers. Materials for training food-service workers have been made available, and interdisciplinary teams have identified models that will strengthen programs. With $1.5 million in special funding, this initiative is developing innovative programs that target special issues.

Waste Management

The Waste Management initiative is providing unbiased information to community decisionmakers on alternatives for the collection, transport, handling, and disposal of waste. Educational programs are providing households with information on reducing the waste stream through composting, source reduction, and recycling. Volunteers have been trained to assist households on the handling of hazardous waste. Extension is cooperating with other public agencies to help local officials comply with regulations and adopt cost-effective procedures in dealing with the growing problem of managing solid waste.

Revitalizing Rural America

Within the Revitalizing Rural America initiative, communities are analyzing their economic bases and implementing plans to improve the retention, development, and expansion of existing enterprises. Areas being emphasized are business development, assessment of economic impact, potential for expansion of trade, and rural development policy. Economic development programs are active in rural communities by providing technical assistance for small and home-based businesses, promoting economic diversity, and enabling local entrepreneurs to assess the benefits and costs of employment alternatives. Other programs focus on prevention of rural crime, land use, and education in public policy for local officials.

Youth-At-Risk

Extension is collaborating with other Government agencies and private organizations to provide training and other educational components for the developmental needs of high-risk youth. The reading capabilities and science/technology literacy of program participants are being enhanced. Educational child-care programs are being established for children 5-14 years old. With funding of $7.5 million from Congress, matched by State and local sources and additional amounts from private sources, Youth-at-Risk programming is being carried out at 69 sites across the Nation. This programming focuses on the care and education of school-age children, community programming for high-risk youths, and development of literacy and technological literacy in youths at risk. Specific actions include

- Identification of seven Centers for Action that provide technical assistance for the 69 programming sites;
- Establishment of eight programming demonstration sites for youths in public housing communities, in cooperation with the Department of Housing and Urban Development;
- Establishment of coalition projects with juvenile judges in 20 communities; and
- A national Youth-at-Risk Summit that demonstrated current programming and established commitment to build local collaborations in youth-development education.

EDUCATIONAL BASE PROGRAMS

Base programs are major educational efforts that are central to the mission of CES. They are ongoing priority programs involving many discipline-based and multidisciplinary approaches that are implemented throughout CES. They constitute the central education efforts of CES and provide the programming base for national initiatives. Base programs have been defined in seven areas as follows:

Agricultural Competitiveness and Profitability

These educational programs emphasize system approaches that maintain and enhance profitability through the application of sound practices of crop and animal production. Farm business management, marketing, decisionmaking skills, and environmental and public-policy considerations are emphasized.

These problem-oriented programs transfer the latest proven technologies to clientele and promote the use of resources consistent with environmental and family goals.

These programs were delivered to a wide range of food and fiber producers and processors on a continuing basis in 1990. One of the highlights was the cooperative efforts of Extension and ASCS in a major educational program that assisted producers in optimizing their production plans under the 1990 Food, Agriculture, Conservation, and Trade Act. This bill places a premium on individual planning in production and marketing. The CES-ASCS educational program contributed significantly to improving the producers' planning and decisionmaking skills in a short time, building on programs developed over the past several years.

Community Resource and Economic Development

Educational programs for community resource and economic development target the development of all community resources, emphasizing economic viability. Communities are assisted in conducting economic analyses that create strategies to strengthen existing firms and attract new enterprises. Programs emphasize leadership and public-policy awareness to improve community services and facilities, housing, and human development in ways that increase community vitality and aid socioeconomic transitions.

Family Development and Resource Management

Educational programs for family development and resource management help individuals and families develop the competencies to become healthy, productive, financially secure, and environmentally responsible members of society. Education is targeted to the management of resources including money, time, apparel, housing, and energy. Individual and family relationships are strengthened, quality care is provided for children, and the elderly are assisted in maintaining their viability and independence.

In 1990, increasing emphasis was placed on rural health and providing care for older Americans. Educational programs are promoting prevention and intervention techniques that emphasize the importance of checkups and early screening for cancer, nutrition for good health, reduction of stress, and improvement of safety in the workplace and at home. Programs for the elderly address issues ranging from adjusting psychologically to retirement and increasing the ability to live independently in later years, to identifying housing options and making after-death arrangements.

4-H and Youth Development

Educational programs for 4-H and youth development focus on building lifelong learning skills that develop the potential of youths. The programs engage youths in healthy learning experiences to increase their self-esteem and problem-solving skills. Programs deal with stress management, self-protection, parent-teen communication, personal development, careers, and global understanding. Offerings on a wide range of topics encourage youths to explore science, technology, and citizenship. Cooperative programs have been initiated with public school systems to improve the technological literacy of youths and to provide stimulating experiences in science.

Leadership and Volunteer Development	Leadership and volunteer development programs empower participants to improve their self-esteem and life skills and to improve the communities in which they live and work. These programs are conducted in most States throughout the Nation. Family and community leadership programs, agricultural leadership programs, and leadership training for local officials are providing large numbers of volunteers with opportunities for development that pays large dividends in their communities and personal activities. The Family Community Leadership program, with support from private sources, offers educational opportunities that prepare participants for involvement in public-policy decisionmaking.
Natural Resources and Environmental Management	Educational programs for natural resources and environmental management focus on the management, use, and sustainability of natural resources with special attention to environmental stewardship and biodiversity. These programs provide information on the management of soil, water, air, plants, fish, and wildlife; aquaculture; forestry; sustainable use and management of rangelands, wetlands, and wildlands; and planning of land use. Many of these programs encourage stewardship that improves timber and rangeland production while maintaining and enhancing wildlife habitat. Programs under the Renewable Resources Education Act assist private landowners and public-land managers with conservation techniques, tree improvement, and financial analysis.
Nutrition, Diet, and Health	Educational programs on nutrition, diet, and health are providing individuals a knowledge base to use in making informed decisions about food, nutrition, and health. These programs are helping persons to achieve and maintain optimum weight, reduce the risk of chronic disease, ensure that newborns are healthy, minimize nutritional inadequacies, and make informed consumer choices related to the safety, quality, and composition of food. In some programs, CES is working with food retailers to provide factual information about foods to the public. Thousands of low-income families are provided information on food selection, sanitation, and kitchen and food safety through the Expanded Food and Nutrition Education Program.

NATIONAL AGRICULTURAL LIBRARY

With over 2 million volumes in the collection and an annual growth rate of 35,000 volumes, the National Agricultural Library (NAL) is the largest agricultural library in the world. It joins the Library of Congress and the National Library of Medicine as one of three national libraries of the United States. The NAL collection encompasses all aspects of agriculture and disciplines, including animal and plant sciences, forestry, entomology, soil and water resources, agricultural economics, agricultural engineering, agricultural products, and food and nutrition. NAL serves employees of the U.S. Department of Agriculture (USDA) as well as scientists, researchers, students, and farmers worldwide.

Text-Digitizing Project Continues

The first phase of the National Agricultural Text Digitizing Project (NATDP) neared completion in 1990. NATDP is an effort by NAL and 45 land-grant universities, using optical scanning technology, to capture page images in electronic format for dissemination on a computerized compact laser disk (CD-ROM). The project seeks to improve access to agricultural literature while preserving it from deterioration. For evaluation purposes, the disks developed by NATDP used different retrieval software packages. The project began in 1987. Under NATDP, NAL has produced CD-ROM's on aquaculture, acid rain, Agent Orange and food, agriculture, and science. Disks on food irradiation and agronomy are in production. While field sites use and evaluate these disks, a software consultant will be reviewing, under NAL contract, additional retrieval software packages for possible use in NATDP.

Image Transmission Project Begun

In 1990, NAL and the North Carolina State University Libraries (Raleigh, NC) began investigating the potential for using the National Science Foundation's Internet telecommunications system to quickly send digitized page images of requested materials to university libraries. Internet connects nearly all U.S. universities. If successful, such a system could be valuable in providing timely access to agricultural information in remote areas nationwide.

Second Optical Laser Disk Developed

NAL developed a 12-inch optical disk containing nearly 16,000 photographs, slides, and other images on agriculture. The disk is part of a system that includes a menu-driven, word-searchable database for improved access to USDA visuals. Access to the images is available by subject, person's name, corporate name, geographic location, or date. The system provides quick access to various collections of agricultural photographs scattered throughout USDA. The disk is a followup to a disk of photographs that NAL produced for the Forest Service in 1988.

Keyword Search Offered

NAL's patrons were offered access to the Integrated System for Information Services (ISIS), a minicomputer-based integrated library system for managing the NAL collection. Through ISIS it is now possible to search the NAL collection not only by author, title, call number, and subject but also by keyword. Boolean search techniques can be applied to all of these elements as well. Remote access to the Online Computer Library Center, Inc., Online

System and to NAL's database (AGRICOLA on Silver Platter CD-ROM) became possible during 1990 by the use of ISIS.

Expert System on Aquaculture Updated

NAL's Aquaculture Information Center completed REGIS II, an updated version of the hypermedia/expert computer system on African aquaculture developed at the library in 1989. The original system was called REGIS (Regional Information System for African Aquaculture). The systems were developed to assist developing African countries in setting up aquaculture operations for profit and as a source of food. NAL was joined in this project by the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce and the United Nations Food and Agriculture Organization. Floppy-disk copies of REGIS II are available at no charge.

Extension Service Compact Disk Created

In 1990, NAL and the Extension Service (ES) completed a joint project to put a variety of ES materials on CD-ROM. The "Extension Service Sampler" disk contains more than 12,000 documents (50,000 pages), 1,500 graphics, 50 computer programs, and 14 minutes of audio. The disk was designed to assist Extension agents across the country in answering the hundreds of thousands of questions they receive each year from U.S. citizens. The sampler was developed with assistance from the Virginia Cooperative Extension Service and the Minnesota Extension Service and was released in March 1990 to 115 test sites for evaluation. NAL updated the disk and had a second disk pressed. It is available for a small software-licensing fee. Eventually, over 1,000 sites worldwide will use the sampler.

Nursery and Seed Trade Catalogs on CD-ROM

NAL has cooperated with Knowledge Access International to produce a multimedia CD-ROM based on NAL's 150,000-item collection of nursery and seed trade catalogs. The prototype CD-ROM was made available for testing during summer 1990. A database, containing bibliographic records, plus selected images from the catalogs are included on the disk.

Oral Histories Videotaped

In 1990, NAL continued its program of videotaping "oral history" interviews with key contributors in the field of alternative agriculture. Each subject of an interview relates his/her early background and experiences in his/her field. The histories are another means by which NAL is preserving agricultural knowledge for future generations. Interviews are being conducted by NAL's Alternative Farming Systems Information Center. The videotapes are available for loan. Subjects of the oral histories include Robert Rodale of the Rodale Institute, noted farm scientist Dr. Wes Jackson, and Dr. James Duke of USDA's Agricultural Research Service.

Rural Health Clearinghouse Established

NAL and the U.S. Department of Health and Human Services signed a 3-year agreement in 1990 establishing a rural health information service to be operated by NAL's Rural Information Center. The Rural Information Center Health Service (RICHS) began operating in fall 1990. RICHS includes a toll-free telephone number for obtaining information on dealing with health-care problems in small communities.

Technology Transfer Center Begun

In 1990, NAL initiated the Technology Transfer Information Center to assist in the conversion of federally sponsored discoveries into commercial products. The center provides Federal research results to individuals and organizations that can put the results to practical use. The center is establishing networks to link people, facilities, and processes that are involved in moving technology from its source to potential users.

Water Quality Center Starts Operating

In 1990, NAL established an information center on water quality. The center is available to assist both the public and private sectors. Creation of the center was spurred by water contamination, pollution, and drought as well as the public's perceptions of the safety of the water supply in the United States.

Foreign Visitors Flock to NAL

Visitors representing the governments of the Soviet Union, People's Republic of China, Czechoslovakia, Denmark, Egypt, Federal Republic of Germany, Netherlands, Japan, Malta, Canada, Mexico, and many other countries were given tours of NAL's facilities and demonstrations of NAL's technologies. Visitors were interested in observing and learning how NAL, the largest agricultural library in the world, manages its collection and provides services to its users.

Bibliographies on Aging Published

In April 1990, a University of Maryland (College Park, MD) professor working on sabbatical at NAL completed a series of bibliographies on aging. The bibliographies offer suggested readings to researchers, educators, and private individuals. The publications were printed and made available, free of charge, by NAL. Subjects covered in the bibliographies include adult children, aging parents, dementia and Alzheimer's disease, family caregiving, family-support networks, grandparenting, humor in later life, intergenerational relationships, living arrangements in later life, pets and the elderly, and sibling relationships in adulthood.

Clearinghouse for Pesticide Training Materials Initiated

With assistance from the Environmental Protection Agency and ES, NAL started a clearinghouse of materials used in the training and certification of pesticide applicators. These materials are being cataloged and added to the NAL collection. NAL enhances the bibliographic records with abstracts describing each training tool and with categories to identify different types of materials. These records will appear in AGRICOLA and in several printed bibliographies produced and distributed by NAL. NAL also entered into an agreement with AI Resources (associated with Goucher College, Towson, MD) and has produced a hypertext database called PEST (Pesticide, Education, Safety, and Training) that covers several aspects of pesticide application.

Cooperation With 1890 Institutions

In 1990, NAL was designated to serve as a USDA "agency cooperator" for two grants awarded under USDA's 1890 Institution Capacity Building Grants Program. The projects covered by the grants are "Center for Agribusiness Studies" at the University of Maryland Eastern Shore (Princess Anne, MD) and "Strengthening the Quality and Effectiveness of Educational Delivery Systems" at the University of Arkansas at Pine Bluff. NAL will work with Maryland's Frederick Douglass Library and Arkansas' John Brown Watson Memorial Library

to help implement the library components of these proposals. The grants program advances the teaching and research capacity of the 1890 land-grant institutions and Tuskegee University. In FY 1990, $5.5 million was appropriated for the program, supporting 29 grants.

Plant Genome Research Program Aided

For more than 2 years, NAL staff have been involved in planning for the Plant Genome Research Program, a new, multimillion-dollar USDA initiative. The program will use basic molecular biology techniques to locate genes of economic importance in agronomic and forest tree species. NAL will provide national and international information and data to the program. NAL is working closely with the National Center for Biotechnology Information at the National Library of Medicine, GenBank, and other institutions involved in the Human Genome Program, research, and related efforts.

Animal Welfare Conference Cosponsored

NAL's Animal Welfare Information Center cosponsored a conference on laboratory animal welfare with the Johns Hopkins Center for Alternatives to Animal Testing. Attendees represented U.S. and Canadian organizations that are involved in generating and disseminating information on alternatives to the use of animals in research. NAL also produced a videotape that describes the activities of its Animal Welfare Information Center and began publishing a quarterly newsletter addressing animal-welfare issues and topics.

Initiative on National Global Change Assisted

During 1990, NAL increased its activities related to global change. Library staff serve on the USDA research team that is guiding departmental efforts, and on a governmentwide working group that is wrestling with data-handling issues. NAL has developed plans for meeting the needs of USDA, other agencies, organizations, and individuals related to information and data on global change. In the near future, NAL will issue a special information packet on global-change issues from the agricultural perspective.

Egyptian National Agricultural Library Aided

NAL is assisting the Egyptian Government in establishing an Egyptian National Agricultural Libary (ENAL) in Cairo. NAL staff are working closely with Egyptian engineer Ragaa Abdel-Hady, Director General of ENAL, on many aspects of the new library. Abdel-Hady is responsible for developing the collection, hiring a staff of 80, and overseeing the construction of the ENAL building, which is scheduled to open in late 1991. The U.S. Agency for International Development has provided funding to NAL for this project.

Preservation Study Completed

A preservation study at NAL, coordinated by the Association of Research Libraries, was completed in 1990. The final report is being prepared for publication. The study found that about 25 percent of the NAL collection is in a state of embrittlement and another 25 percent needs immediate preservation attention. Plans for improving the condition of the collection by establishing a preservation program at NAL are included in the report.

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